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Eco- Zero Weeding Agriculture to Produce Exemplary Yield of Onion – A Corroborative Study

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Abstract

Studies on eco- zero weeding agriculture revealed exemplary yield of garlic (*Alium sativa* L) Since garlic and onion are from same alium family, their growing and agronomical practices are entirely same. It is found from the literature survey that lot of researches were conducted and tremendous repetitions taking place. There is scope for corroborative study of Eco Zero weeding agriculture, which is entirely a new dimension in agriculture. Objective of this study was to determine such exemplary yield scenario for onion, by using corroborative factors established for garlic. The new aspect of eco-zero weeding agriculture was abstracted for its salient feature for updating readership. The management practices of onion and resulting yields of onion were contrasted with results that were obtained from the corroborative eco-zero weeding agriculture. This study revealed an exemplary yield of onion (87.5 Tones/ha against general yield of 37 Tonne/ha) and resulting net return (Rs 8, 16,312/ha). As advancement in research methodology, it is further revealed that application of corroborative study approach can be resorted to for fostering research efforts for selected species of any crop of given family of horticulture. The exemplary yield opportunity can be utilized for enhancing commodity production and stabilization of price in the markets. Thus, it will benefit consumers, growers, traders, society and country's effective governance. The enhanced land equivalent ratio (LER) will enable making land available for other crop diversification i.e. use of costly, non-renewable and fixed land resources for overcoming Earth overshoot.

Keywords: *Garlic; Nitrogen fixation; Pollution control; Weed management; Weedicide; Yield enhancement*

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Introduction

Onion (Alium cepa L family Amaryllidaceae), a key nutritional vegetable, spice and medicinal crop contains carbohydrate (11.0g), protein (1.2g), calcium (180 mg), phosphorus (50 mg), iron (0.7 mg) nicotinic acid (0.4 mg), riboflavin (0.01 mg) and vitamin C (11 mg) in each 100 g edible portion (Bose et cited in Sharma et al.,2017). India is next to China in area, production and productivity. Among different states in India Maharastra is leading state in terms of area and production. Other major onion producing states are Gujarat, Karnatka, Orissa, Uttar Pradesh, Andhra Pradesh, Tamilnadu and Rajasthan. The area of onion n Madhya Pradesh is 117.3 thousand ha, total production 2826 thousand million tone and productivity about 24.1Ttonne/ha (NHB 2013-14).

Onion in India is grown in three growing seasons viz rainy season, late rainy season and winter season. The rainy season and late rainy season cultivation of onion gives about 40% of total onion production, whereas that in winter season supplements remaining 60%.

Nitrogen fosters plant metabolism that enhances growth factors and yield of onion bulbs. Sulphur increases size of bulb, pungency and flavor, and keeping quality. Sulphur, phosphorus and potash enhance nitrogen use efficiency even at same level of water availability. Endless researches were conducted on integrated nutrient management for onion, but the response is marginal, i.e. not very remarkable. Cultivation of onion in rainy as well as late rainy season undertaken with high expectation of fulfilling demand and supply gap and have control on market price, do not become successful due to intensive weed infestation and un manageable situation As indicated earlier, study was initiated on cultivation of onion during rainy season, where weeding is the main factor limiting successful crop of onion.

Experiment was sown with black gram as eco making crop and onion as the main crop in rainy season on onion with black gram as eco crop. The farm allowed grass cutting people to cut and carry grass. The grass cutting people harvested entire crop leaving the scientists in helpless situation for the research of weed, leading to not very encouraging results.

In earlier study an innovative technology of eco-zero weeding agriculture resulted exemplary yield of garlic (Yadav and Yada, 2017). This innovative technology will have its due diffusion time for coming to peoples' knowledge and adoption for cultivation, it demand a faster approach to fortify spread of the eco-zero weeding agriculture technology application for onion as well. Objective of the present study was to determine such exemplary yield of onion by application of eco-zero weeding agriculture technology as a corroborative study of previous results of garlic, since both the species belong to the same family, have same row to row and plant to plant spacing and total plant population as well as agronomic practices. The exemplary yield so obtained are contrasted with most recent and meticulously conducted and yielding study on onion (Sharma., *et al.* 2017).

Materials and Method

Experimental details of eco-zero weeding agriculture study on garlic producing exemplary yield

Experiments were conducted at experimental farm of Tirhut College of Agriculture, Dholi, North Bihar, India during rainy season (*kharif*) and winter season (*rabi*) 2016-17. The farm is located on the southern bank of river Burhi Gandak command area of north Bihar at 25.98°N latitude, 85.6°E longitude and at an altitude of 52.18 m above mean sea level.

The soils of experimental site was calcareous alluvial in nature and slightly alkaline in reaction. The soil texture in general is predominantly loamy and sandy loam with pH ranging from 8.2 to 9.4. The average annual rainfall is about 1270 mm, out of which nearly 1026 mm was received during monsoon extending from the middle of June to middle of October. The period between 3rd weeks of December to 1st half of January enjoys occasional winter showers. The hot weather commences from April and remains up to middle of June. The summer temperature occurs from May-June between 37°C to 40°C and the minimum temperature for the same period between 17°C to 21.8°C. During rainy season average maximum temp remains about 33.9°C, average minimum about 25.3°C. January is coldest month and average maximum 23.1°C & minimum of 7.7°C. The onion variety agrifound Dark red was planted during kharif and winter crop.

The manures & fertilizers were applied as per local recommendation 25 q/ha FYM, 120 kg N/ha, 80 kg P_2O_5/ha, 100 kg K_2O /ha and 40 kg S/ha in both the crops. FYM was uniformly spread in the field before ploughing of the plot ½ nitrogen, full phosphor, potash and sulphur was applied before planting of onion seedlings & sowing of garlic cloves. Onion seedlings were transplanted at 6 weeks age, however, garlic cloves were planted at 15 cm x 10 cm. Rest nitrogen was applied in two equal doses after one month & 2 months after transplanting of onion & sowing of garlic cloves. Inter crop (black gram and lentil) as per plan was sown after planting onion & before sowing of garlic. Irrigation & other plant protection operation were done as per need of the crops. The nature of peculiarity of crops, management of fertilizers etc., will be taken up in discussion part of results.

- Treatments

The treatments are decided to fit in the narrow range of variation of nitrogen fixing crop to be sown as broad casting before transplanting. The crop may be different viz lentil, alfalfa or peas for garlic and onion, which are cultivated in winter season and black gram or green gram for onion in rainy season. While the green gram and black gram are suitable crop for fixing nitrogen in onion during rainy season, lentil is suitable crop for that purpose in both crops during winter season. In this context a non legume, no nitrogen fixing crop, but effective in phosphorus solubilization is fenugreek will offer insight for management of phosphorus. This study was conducted on garlic with lentil during winter season 2016-17. Full experimental details are available in another study (Yadav and Yadav, 2017)

Conventional experiments for onion and resulting yields

It is evident from the study (Sharma., *et al.* 2017) that most of research efforts have been on onion and only a fraction on garlic [Table 1]. It is also clear that most of researches had been concentrating on NPK nutrient management. Other nutrient elements are getting scanty research attention. Researches on genotypes and system factors are within 10%. Research on off season cultivation of onion are very little, plant physiological measures, growth promoters, enzymes and economics have touched only fringe of research domain. There is no attempt on potential research area such as eco zero weeding, and weed management that will several benefits and on potential measures for enhancing the land equivalent ration. Therefore, it is clear that unless some innovative efforts are devoted, substantial benefits from the measures will not emerge. Scientific progress made and its exemplary yields revealed inspired to determine the yield of crops of same family and complete scenario of research within short time.

Since the onion and garlic are crops of same family, where cultivation, line to line spacing and plant to plant spacing, even fertilizer and irrigation are exactly same, hence an endeavor was made to utilize the important aspects of crop performance indicators and compute yield of onion, which attracts equal interest of horticulturists (Sharma., *et al*. 2017); as established by list of references of the referred article.

S. No	Factors	Sub factors	Onion %	Garlic %	Total %
	Researched areas				
1	Varietal	Genotype	8	-	8
2	System factors	Land and water	8	-	8
3	Plant physiological	Spray for growth	4	-	4
4		Humic	4		4
5	Agronomic	Planting date	4		4
6		Rainy season	4		4
7	Nutrients	Nutrient N,P,K,Zn,Cu	48	8	56
8	Potential nutrients	Mixed org +Inorga	8	-	8
9	Enzymic fortification	Enzymic;vermin compost	4	-	4
10		B:C Ratio	4	-	4
		Total	92	8	100
	Potential research Areas				
11	Weed Control	Eco-zero weeding	?	?	?
12	LER enhancement	Inter cropping	?	?	?

Table 1: *Scenario of researches on onion and garlic.*

Corroborating factors

The onion and garlic are dense close growing transplanted crops; the plant population/ha is very high. The usual row to row spacing is 15 cm and plant to plant 10 cm. Weed control is carried out manually, that involves huge cost of cultivation, a reducer of net benefit. Since this is the first study on this topic addressing new aspect of eco-zero weeding agriculture (Yadav and Yadav, 2017) main focus was to address the major benefit of this innovative technology on enhancement of yield of garlic. Efforts concentrated to substantiate the relevance, effectiveness, efficiency, impact and sustainability of the technology with theory and experimentally generated data on ideal crop of garlic. The entire concept is based on innovative application of nitrogen cycle management. Among various benefits, the most challenging is the management of weeds, which consume nutrients, cause solar light, nutrient, moisture and space completion and cause drastic reduction in yield of crop. The eco zero weeding agriculture produces benefits in several aspects, which will be taken up by the later of the studies.

- **Yield variation in relation to weeding**

The data on yield per plot was recorded and presented in Table 2 The yield of garlic in no weeding and no nitrogen fixing eco crop was 55.5q/ha and of T7- fully weeded plot 35.5q/ha. Thus, no weeding treatment produced 20 q/ha more yield than that with fully weeded plot. On the other hand weeding involved investment of high cost. This situation indicates a fact which otherwise is contrary to common belief that weeding will overcome crop loss, in general. Since garlic is shallow rooted crop, weeding involves tilling of surface layer that causes drying of shallow root zone of garlic, hence producing stress for the crop. In the no weeding case there is nitrogen fixation even with weeds that support crop on one hand and no disturbance to cause moisture loss from shallow root zone. This mechanism is more effective in experimental site with light loamy and sandy loam soil at *Dholi. Samastipur, Bihar.*

Treatment No.	Treatments	TDW (Kg)	LER	LER for green gram and pearl millet	TBY/plot (q/ha)
T1	Garlic; no Lentil	1.330	1.0	1.0	55.5
T2	Garlic + 25% Lentil (1g)	2.740	2.06	1.34	114.0
T3	Garlic + 50% Lentil (2g)	2.670/3.0087*	2.01/2.321*	1.51	111.4/125.5*
T4	Garlic + 75% Lentil (3g)	1.882/2.004	1.415/2.044	1.39	78.5/98.9
%5	Garlic 100% Lentil (4g)	1.702/1.923	1.28	1.23	71.0/80.2
T6	Garlic with full package, No Lentil	0.850			35.5

Note: TDW-Total dry weight, TBY-Total bulb yield;

Table 2: *Yield data from a pilot trial on zero weeding eco agriculture.*

Optimum dose of nitrogen fixing eco crop and resulting maximum yield

The optimum seed rate was 51%. With this optimum seed rate the maximum yield of garlic was 111 q/ha. The experiment result had revealed highest yield of 114 q/ha, but it got moderated and the corresponding maximum yield was 111 q/ha. This situation indicates that inter-competition must have suppressed crop of garlic, hence the maximum yield got reduced from 114 q/ha to 111 q/ha. There can be some reason related to precision and care required in the study. In order to study trend how yield can respond when some potential improvement care is infused in data at level 50, 75% and 100%, based on trend observed in another study (Yadav., et al. 2013) and incorporated changes indicated in Table 3. Using the data another polynomial relation was derived [Figure 1]. The coefficient of determination increased to almost 90%., thereby revealing possibility of enhancing yield by better crop management with respect to fixation of nitrogen. The weeding is not being carried out as it is zero weeding agriculture, inoculation of nitrogen fixing bacterial compound would be prospecting approach. The optimum dose of eco crop assessed was 55%, and the maximum yield of garlic corresponding to this optimum dose of eco crop through the polynomial relation was 125 q/ha. This increase fortifies that experiment needed some better care and bad effect of inter-competition can be shifted further to harvest higher yield. Still better crop management does indicate possibility of better prospects, which will be taken up in the subsequent part of the study.

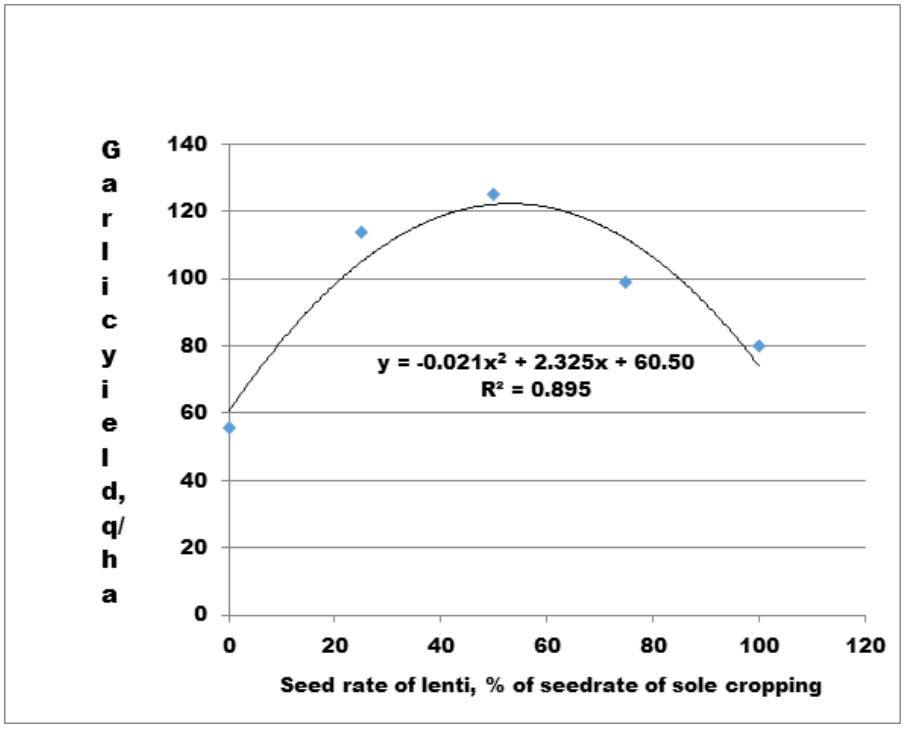


Figure 1: *Polynomial equation for yield after adjustment for potential increase.*

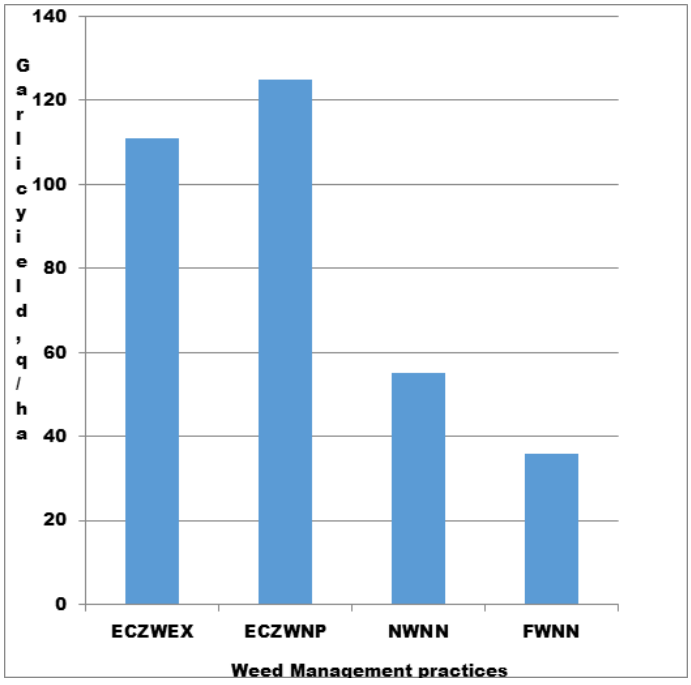
S. No	Use of data set	Polynomial relation	R^2	Maximum yield at seed rate,%	Maximum yield, q/ha
1	Actual recorded	$Y = -.018X^2 + 1.836x + 63.79$	.713	51	111
2	With slight adjustment at 50% seed rate and beyond	$Y = -0.021X^2 + 2.325x + 60.50$	.895	55	125
3	No weeding no nitrogen management	-	-	-	55
4	Fully weeded, but no nitrogen cycle management	-	-	-	36

Table 3: *Determination of optimum rate of lentil seed for eco-zero weeding agriculture for garlic.*

The different methods of weed management and their effect on yield are shown in Figure 2. The existing practice of weeding, by manual weeding in garlic, involve high cost, thereby will reduce B/C ratio for the cultivators. Treating this as a control, the LER will be 1. As against this zero weeding agriculture with eco-agriculture practice developed in the present study show great prospects for enhancing yield of garlic, a close growing crop, for which no innovative practice could be devised. As indicated, there occurred some inadequacy of experimental care, nevertheless the data revealed prospects of eco-zero weeding for garlic. This fact reveals that the technology of eco-zero weeding agriculture is robust and effective in wide range with tolerance. It is found that lentil sown at 51% of normal seed rate of sole crop of lentil produced maximum yield 110 q/ha. With slight improvement in yield of this study at per trend established in other parallel experiment the yield of garlic reaches to125 q/ha, which is an exemplary yield of garlic. Further, there is scope of enhancing nitrogen fixation by inoculating phosphorus solubilizing bacterial compound. Application of ultimate green irrigation to keep the surface layer at 75% of saturated moisture by sprinkler irrigation will prove boon for shallow rooted garlic crop. Thus, this study has opened new door for prospecting cultivation of garlic.

- **Weed management practices and their effects on yield of garlic.**

A summary of weed management practices and resulting yield are presented in Figure 2. Eco–zero weeding agriculture has shown enormous yield increase. Some improvement in practice will further enhance the yield, which otherwise were not imagined. No weeding even increased yield. Similar effects were found by another study (Banik., *et al*. 2006). In the study it was found that weeds reduced yield up to 28%, against yield of fully weeded crop of wheat. The residual nutrient in soil was about 24% more than in control without weeds. When weeds include alfalfa the loss in yield due to weed was reduced to 16%. In the densely planted garlic crop the presence of weeds increased yield instead of depletion, because of drying of surface soil in weeding induced disturbance of soil layer. It also fortified that weeding is proving ineffective and costly. Thus, these results confirm and display good approach taken up in conceptualization and experimentation that yielded promising result leading to innovative eco zero weeding agriculture technology. This study has created new avenue for rainfed agriculture in particular and irrigated agriculture, in general. This innovative technology surpasses all innovations being developed to meet challenge of weed management in world agriculture, viz weeding by robot, smart agriculture and specialized weeding machines. The adverse weather condition make these innovative technology inapplicable and ineffective, so problem of weed management remain unsolved. In this situation eco –zero weeding agriculture proves to be the best technology, as it is non-monetary input practice, remain working under all adverse condition of weather creating non conducive for field operations.



ECZWEX- eco-zero weeding nitrogen cycle management under this experiment; ECZWNP-eco-zero weeding nitrogen cycle management potential effects; NWNN-No weeding no nitrogen and FWNN-fully weeded manually, but no nitrogen cycle management.

Figure 2: *Yield of garlic under Eco-zero weeding agriculture versus no weeding no nitrogen management and full manually weeded, but no nitrogen cycle management.*

With the fore mentioned example cases it is sufficiently substantiated that pulse based eco zero weeding agriculture produces multiple benefits of increase in LER, increased benefit cost ratio (B/C) [Table 3], weed control, reduction of erosion and land degradation, increase in drought endurance, potential for insect and pest control etc. The yield increase with sustainability and quantity enhancement are substantiated. Thus, new toil free eco-agriculture showed the present and future yield potential with the technology

presented in the study. The potential yields will get easily achieved by combining again a supplementing technology of racy nature agriculture (Yadav, 2013, Yadav and Chaudhary, 2014). If suitable moisture building mechanism is created, still higher yields than achieved can be harvested. Yadav (2015b) developed ultimate green irrigation practice for this purpose, which will be highly suitable for shallow rooted crops such as garlic and onion.

The fore going results on manifolds enhancement of yield of garlic by the innovative technology culminating in eco zero weeding agriculture have been substantiated to be effective.

Result

Comparison between nutrient levels

The study (Sharma., *et al*. 2017) on nutrients presented in Table 3 reveals that N application was more than that in Eco–zero weeding agriculture experiment on garlic, but other nutrients viz, phosphorus and potash etc were not taken care of in the study (Sharma., *et al.* 2017). Other micro nutrients were also not applied.

Comparison of nutrient status between reference study and corroborative study

S. No	Nutrient types	Sharma., *et al*. 2017	Experiment under Eco-zero weeding agriculture*
1	N	140	136
2	P	30	80
3	K	-	121
4	S	30	52
5	Fe	-	8.2
6	Man	-	2.9
7	Cu	-	.19
8	Zn	-	1.463
Yield		34000	87500
Economics		260962	816312

*Remark Nutrients seem to be sufficient, inoculation of pulse crop lentil of eco-zero weeding crop with *Sinorhizobium meliloti and Bacillus megaterium*) should be adopted that will further enhance yield of garlic.

*Contents based on Biswas., *et al.* 2012.

Table 4: *Different level of application of nutrient in well-conceived study on onion and that had been with eco-zero weeding agriculture producing exemplary yield of garlic.*

Figure 3 reveals that the effect was brought by eco-crop and its inoculation and addition of peas will help phosphorus solubilization. This aspect can be created that will further increase efficiency of eco-zero weeding agriculture. Nevertheless, the present field experimental study accomplished its desired objective of validation and substantiation of the new innovative technology of eco-zero weeding agriculture. The supplementary nutrients were created by addition of 2.5 Tonne compost. Change of aerobically decomposed compost (popularly, known as NADEP in India) will create more sulphate, and organic major (macro) and micro nutrients. Thus, there will be still better nutrient status of soil for onion and garlic. Such nutrients will facilitate microbiological activity that makes agriculture alive for all time, a designated goal in the eco-zero weeding agriculture.

Comparison between yield produced by all efforts and that obtained with eco-zero weeding agriculture

The study (Sharma., *et al.* 2017)-SRS shows low level of yield of onion and against this yield from the corroborative study on eco-zero weeding agriculture is about 2.75 time more (Figure 4). Similar is the situation with economic net return to the growers of onion under eco-zero weeding agriculture.

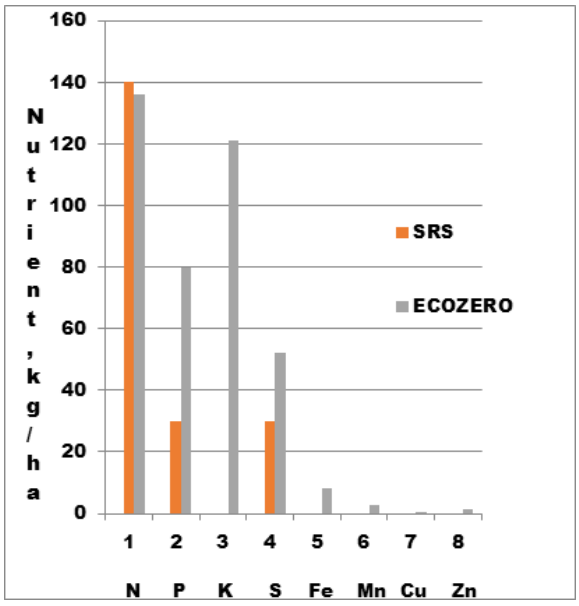


Figure 3: *Comparative levels of Nutrient in SRS and Eco-Zero for onion.*

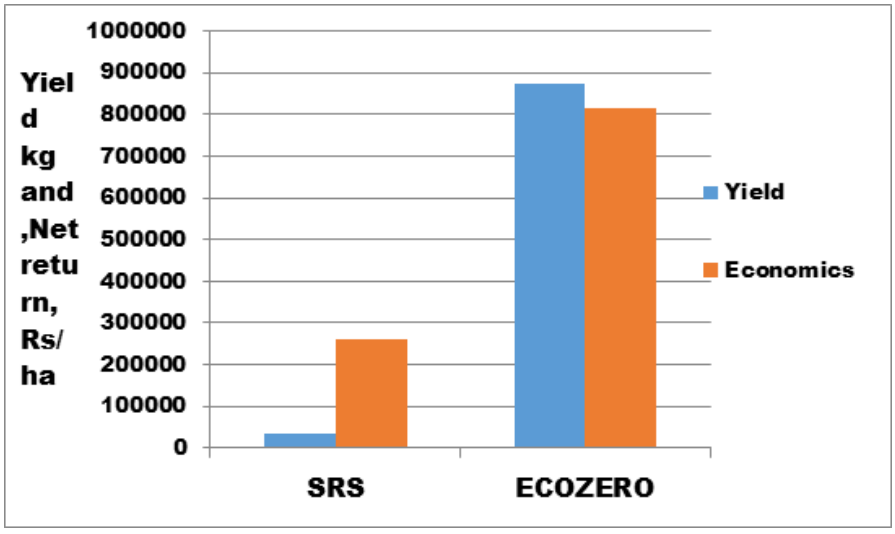


Figure 4: *Yield from SRS and Eco-Zero Weeding.*

S. No.	Crop details	Yield under control	LER	Yield, q/ha	Gross income	Gross return	Cost of cultivation	Net return, Rs/ha
Garlic,								
1	Control	36	1.0	36				103500
2	Expt	114	3.2	114				166500

3	Export	125	3.5	125				341366
Onion sale price, Rs1000/q								
4	Control	250	1.0	250	250000		56000	194000
5	Expt	310	1.24	310	310000		57000	253000
6	Expt	340	1.36	340	340000		58000	282000
Eco-Zero Weeding agriculture								
6	Control	250	1.0	250	250000	56000	56000	194000
7	Exit	310	3.2	800	800000	57000 +634	57634	742366
8	Expt	340	3.5	875	875000	58000 + 688	58688	816312

Table 5: *Relevant details of factors adopted in assessing productivity of onion on the patterns observed data from experiment on garlic.*

Yield performance of onion under integrated nutrient management (Sharma., *et al.* 2017) was conducted at KVK, Chindwara, in Madhya Pradesh on productivity of onion with five levels 0-140 Kg N/ha and Sulphur 0 40 kg/ha. The data provided opportunity to make comparison of N and S that were obtained in the experimental condition of garlic. Data were set for garlic experiment under Eco–Zero weeding, Sharma., *et al*. 2017 study and onion under eco-zero weeding. The range of productivity is larger for onion than that for garlic.

Net return

Relative graph of productivity reveals that net return from the onion under eco-zero weeding are 2.5 times more than the net income from garlic [Figure 6]. The eco zero weeding is highly effective as it creates biological N supply in addition to the nutrient management practices adopted in usual practice for onion. The yield of rainy season onion will also increase that will smoother soaring price of onion in the market during the off season. This situation is highly beneficial for the people and high net return has already shown many fold gain to the onion cultivator. In the recent decade onion has been a costly commodity and poor farmers had left access to onion except during the main crop months. The high productivity will overcome earth overshoot. It will bring earlier days of plentiful availability to the low income group viz labourers. Now the governments need to create infrastructure for storage and onion processing industries to let the growers not get in loss. Thus, the situation of onion is still better and the need appraisal that eco –zero weeding agriculture has shown its promise not merely for garlic and onion, but for all crops. This aspect will get proven and demonstrated by scientific group to farmers and public in general.

The application of nutrients in study by Sharma., *et al*. 2017 and that is shown in experiment on Eco–zero weeding and different dose of N and S are equal or even less, but yield of onion under eco-zero weeding agriculture are many fold more, resulting in very high net return to onion growers. This situation will prompt growers to cultivate onion more than the garlic. Now in this situation Government/ public should not curse the onion growers for huge production of onion, instead encourage growers to make profit and harness benefit. Thus, attitude of the Government on encouraging growers of agricultural commodity should help create wealth for public and country. His Excellency Past President late Dr A.P.J Abdul Kalam had been keeping hope on another green revolution to come. Accomplishment of challenge by eco zero weeding is real fulfillment of his cherish dream. It warrants to take cognizance, accept and promote this research. This is a very healthy and prestigious scientific development on food front in India.

- **Comparison of yield of onion from similar study N and S doses**

Discussion

The innovative technology of eco-zero weeding agriculture is highly suitable for cultivation of garlic crop, particularly with regard to weed management. Weeding in high density planted crop is time consuming that demands cost. Further, the general belief that weeds interfere and reduce yield of crop is revealed to be not true, as garlic yield was more under no weeded treatment. Thus, no benefit of

weeding has been found to accrue in the soil condition where top soil layer gets quickly dried and crop suffers moisture stress, resulting in reduction in yield on one hand and expenditure on account of cost of weeding. The yield of garlic with no weeding was more, that fortifies fact of some nitrogen fixation by weeds supported increase in yield of garlic against fully weeded crop of garlic.

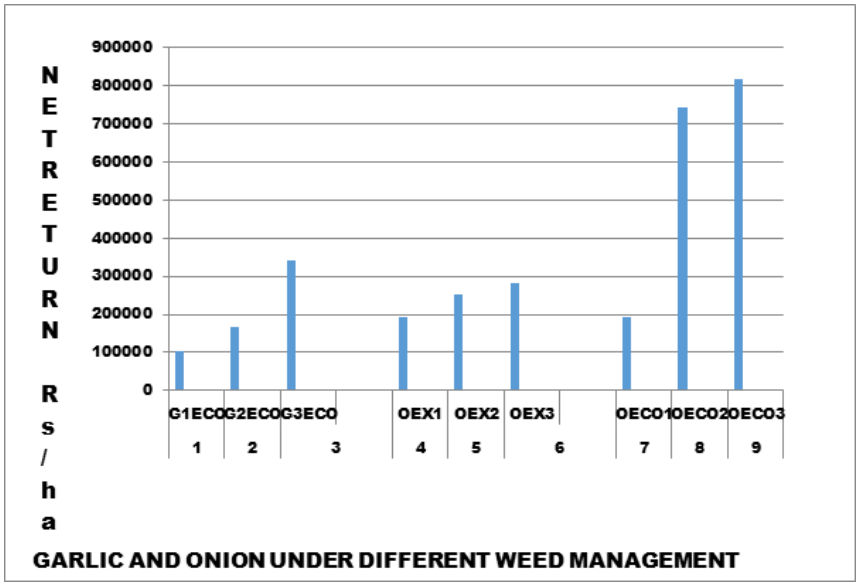


Figure 5: *Corroborated yield of onion under eco-zero weeding agriculture.*

The trend of variation in gain in yield of garlic under fully weeded and no weed plot at various level of eco establishment make it clear that crops sustain competition up to about 50 eco establishment. Drastic reduction occurs due to competition that reveals a polynomial trend of variation.

The polynomial analysis and trend of variation in yield of garlic showed that dependence of yield on nitrogen fixation was 71%. The optimum dose of eco level was 51 percent and with this dose the optimized yield of garlic was 111q/ha. The influence of technology on enhancing garlic yield is robust, hence it overcome the inadequacy of experimental precision to some extent. In order to see response that if some better crop management practices is given to the garlic crop, some innovative potential management support was given [Table 5] that revealed the dependence of crop on nitrogen fixation up to 90%. This condition enhances tolerance of competition and increase in yield up to 875 q/ha, which are very well and strongly revealed efficacy of the technology. In the context of improvement in component practices to make it still better than the level demonstrated so far. The step by step component review is to be resorted to. The crop density is maintained thus, entire space is contributing some yield to form global yield /ha. Since it is zero weeding hence that part is also fortified with evidentiary facts. It is only nutrient and irrigation part that needs some specific review.

In the ongoing practice onion field is applied 25 q/ha FYM, 120 kg N/ha, 80 kg P_2O_5/ha, 100 kg K_2O/ha and 40 kg S/ha. Taking account of NPK and sulphur status of the crop some insight of prospect of management can be clear.

The nutrient status is sufficient. Study on fenugreek (Adak and Sachan, 2013) showed that such doses of nutrients are efficiently utilized when microbial nitrogen fixation occurs, solubilization of phosphorus induces high uptake by grain and straw. Yadav (2012, 2013) showed that application of aerobically decomposed compost, which adds organic sulphate will enhance yield of sulphur loving crops such as garlic and onion. Thus, in onion this effect will get to produce still higher yield. This aspect has been shown vide Figure 4 and Figure 5. Thus, it is becoming clear that addition of PSB will be effective as the eco fortifies the organic N. Inoculation of rhizobium culture will be very effective that will enhance efficiency in increasing crop yield. So far researches have been conducted on effect of

inoculations on yield of fenugreek (Adak and Sachan, 2013), microbial formulations (Sharma., *et al*. 2013) on yield of tomato and biological health of soil of different cropping systems (Manna., *et al*. 2013), This innovative study developed an exemplary yield producing technology of weed management in agriculture world over, in general. In this situation the knowledge of the microbiological aspects, can be made use of to enhance efficiency of the eco-zero weeding agriculture in time to come.

The study has demonstrated increase in LER and Net Return to the cultivators. These aspects will make the eco-zero weeding agriculture highly attractive for the cultivators. This technology also eliminates risks of crop failure due to bad weather condition, particularly rainfed agriculture. The innovative technology also helps make right public governance. These and many beneficial aspects will get quantified by further researches, as the first part of the technology of eco zero weeding agriculture has been proven, beyond any doubt.

The eco –zero weeding agriculture, which is a manifestation of practice from management of nitrogen cycle (Yadav, 3012, 2013, 2014, 2015a,) is very relevant innovative technological solution of problem of weed management in world agriculture. It is the most effective in weed management as its working continues under even unfavorable weather condition induced not workable condition in the field. The present study has established efficiency and effectiveness. In addition to the benefit of yield, increase in LER and net benefit, this eco- zero weeding agriculture works as panacea shrine for total solutions in agriculture. As the success of good crop is assured under all-weather situations, the technology is highly sustainable. Thus, eco-zero weeding agriculture technology fully meets all aspects of the relevance, effects, efficiency, impact and sustainability (REEIS).

Strength, weakness, opportunity and threat (SWOT) analyses was also carried out as it becomes desirable aspect for any new innovation. The eco-zero weeding agriculture is based on the theory of nitrogen cycle and is also backed for its robust working under field condition, hence it has very high strength. It overcomes and surpasses all worldly innovations for weed management in agriculture. As the other innovations have some limitations and among them the most prominent one is no functioning under the unfavorable condition due to aberrations in weather. The climate change is adding to the severity of this limitation. The eco-zero weeding technology is having no limitation of any kind, hence, there exists no threat to this innovative technology in meeting all challenges of weed management in agriculture. Regarding opportunity, it is emphasized that it is practically non-monetary input involving technology (as revealed by the expenditure data in Table 4).

Eco-Zero weeding agriculture is a panacea shrine for total solutions viz for enhancimg net return, reduction of runoff and soil loss, elimination of land degradation due to nutrient deficiency, making shortfall in pulse production and reduction of greenhouse gas-nitrous oxide (N2O) emission (Yadav,2014, 2015a), largely responsible for depletion of ozone layer (Wubble,2009), that shows huge opportunity created by this technology. The corroborative study creates advancement in research methodology for accomplishing results in short time by conducting some field experiments on selected species of crops. Other species can be studied by such corroborative studies. A new scenario of research can be created in short time and with low budget involvement. This expertise will attract call for consultancy services in time to come.

Conclusion

The corroborative study on onion produced exemplary yield of 875 q/ha against maximum yield with optimized doses of N and S (340 q/ha). While N and S doses were comparable, application of farm yard manure and nitrogen fixation by eco-zero weeding produced exemplary yield and far more economic return than the case under conventional experimentations. This study revealed that the exemplary yield of onion (875 q/ha against general yield of 340 q/ha) and resulting net return (Rs 8, 16, 312/ha). This eco zero weeding technology will be functioning under all-weather condition, everywhere and all times, as a sun technology, surpassing any bright spot creating technology that glitter for shot time like firefly. It is further revealed that application of corroborative approach proves as advancement in research methodology for fostering research efforts for selected species of any family of given horticulture crops. The new corroborative study on different family of crops will produce research information on efficiency of most of the vegetable crops, cereal, oil seeds and even. pulses. This eco-zero weeding agriculture is based on proven theory and substantiated by experimental data The

enhanced land equivalent ratio will enable making land available for other crop diversification i.e. use of costly, non-renewable and fixed land resources for overcoming Earth overshoot.

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