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Evaluation of agronomical practices of weed management in garlic under organic production system

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Abstract

An experiment was carried out in the field of at Kuthulia farm of JNKVV, College of agriculture, Rewa (M.P.) under all India coordinated research project on farming system during *rabi* season 2020-21. The garlic variety was given the experimental design was conducted in a RBD with three replications. The garlic crop was planted on 17/10/2020 at planting geometry of 20 cm x 10 cm in all treatment except in T₄ (Stale seed bed + reduced spacing up to 25% + mulching with paddy straw + one hand weeding) in which row to row spacing reduced in 25%. The nutrient was applied at the rate of equivalent to 120 kg N/ha through 1/3rd N through from FYM, 1/3rd through vermicompost and 1/3rd through mustard oil cake while in T₆ and additional amount of mustard oil cake 5 t/ha was applied in garlic crop. The garlic crop was harvested was 3rd and 4th April 2021 and was fertilized with the manorial dose 120 kg N through FYM, vermicompost and mustard oil cake as given in rice. The treatment were T₁ (Two hand weeding at 25 and 50 DAT), T₂: (Cono weeder-25 DAT + one HW at 50 DAT), T₃ Inter cropping with Dhaincha in rice and mustard in garlic in 3:1 row system), T₄ (Stale seed bed + reduced spacing up to 25% + mulching with wheat straw +one hand weeding), T₅ (Locally available weed mulch + 1 hand pulling), T₆ (Incorporation of mustard oil cake 15 days before sowing @ 5 t/ha + 1 HW) and T₇ (ITK treatment on weed control practices by farmers as mulching with leaf of mango). The same weed control treatments were given in rice and garlic and planted in the same layout and field. The both crops were grown under organic production system.

Keywords: Garlic, weed management, organic production

Introduction

Garlic is an important medicinal high value crop. Garlic is a bulbous perennial herb, closely related to the onion. It is the second most widely cultivated crop in the family Alliaceae after onion (Ahmed *et al.*, 2007) ^[1]. The part used medicinally is the bulb. It has one of the best-researched herbal remedies, holds a unique position in history, traditionally employed to treat infection, colds, diabetes, heart disease, and a host of other disorders. Garlic shows anti-viral, anti-bacterial, antifungal, antioxidant, anti-atherosclerotic and anti-cancer properties.

In India, the total area under garlic cultivation is 3.53 lakh ha with the production of 29.18 lakh tones and average yield is 8025 kg/ha. Rajasthan is the highest garlic producing state in India sharing 52.87% of total production of India followed by Uttar Pradesh 17.13% and Gujarat 13.72%. The area under garlic in Madhya Pradesh is 1.8 lakh ha with the total production of 18.33 lakh tonnes with the productivity of 10.15 tonnes/ha.

Although the research work on different aspects of garlic cultivation has been conducted, yet weed control problems still need to be addressed. The total losses in garlic cultivation on account of high weed competition are recorded to be much more as compared to be other horticultural and cereals crop.

The weeds like *Medicago hypsipida*, *Cyperus rotundus*, *Chenopodium album*, *Euphorbia hirta*, *Heliotropium indicum*, *Vicia sativa*, *Anagallis arvensis*, *Phalaris Minor* and some winter grass weeds infested the garlic crop to a great extent.

Weeds became most limiting factor in organic farming under irrigated condition. Some cultural practices like close row spacing, high seed rate, stale seed bed, mulching by crop residues or tree leaves, late hand weeding and hoeing are being found effective to reduce the weed problem

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under organic production system. Any practices aimed at enhancing competitive ability of the crop and weed can bring down the adverse effect of weeds on garlic. Seedling vigour, early growth rate, stale seed bed, higher dose of nutrient application and mulching can give competitive advantage to garlic crop. Prajapat (2019) ^[4] has reported that hoeing at 25 DAP and one hand weeding at 50 DAP was better than mulching and intercropping with mustard in organically grown garlic as weed control practices. However, 2 hand weeding at 25 and 50 DAP was best for weed control in organically grown garlic. Singraul *et al.* (2020) ^[5] has obtained maximum garlic yield 111.89 q/ha under the application of mustard oilcake 50 q/ha + one hand weeding at 50 DAP which gave 114.34% higher bulb yield over farmers practices of mulching as weed control practices in garlic. Two hand weeding at 25 and 50 DAP as weed control treatment in garlic gave 72.52% higher yield over mulching with mango leaves. Use of mustard oilcake at higher level has been found beneficial as it increases the growth character of garlic which has ability to suppress the weed growth (Islam 2007 and Prajapat 2019) ^[3,4].

Intercropping suppress weeds better than sole cropping and thus provides an opportunity to utilize crop themselves as tools for weed management. Cultivation of garlic at narrow/close row spacing has been found effective to reduce the weed growth and increase the yield as compared to wider spaced crop. It has been reported by Bond and Grundy (2001) ^[2] that organic farming is gaining momentum in India owing to the concern expressed on

the safety of environment, soil, water and food chain. Cultivating crops organically and at the same time maintaining higher production level is a big challenge. Since chemical intervention is not permitted for weed management, non-chemical weed management is the major limitation in garlic under organic farming. A concern about the potential increase in weed population due to non-use of herbicides is rated as serious problem in organic farming. Keeping above fact in view the present experiment has been taken with following objective.

Materials and Methods

An experiment was carried out in the field of at Kuthulia farm of JNKVV, College of agriculture, Rewa (M.P.) under all India coordinated research project on farming system during rabi season 2020-21. The soil of experimental field was silty clay loam in texture, nearly neutral in reaction (pH 6.8), low in organic carbon (0.42%) and low in available nitrogen (180.31 kg/ha) medium in available phosphorous (16.93 kg/ha) and higher in available potash (283.63kg/ha). The total rainfall was 1013 mm during the year while in rabi season only 10.16 mm rainfall was recorded. The maximum and minimum temperatures recorded during the crop season were 36.17 °C and 5.10 °C in the month of April and February, respectively. The garlic crop was planted on 17/10/2020 at planting geometry of 20 cm x 10 cm in all treatment except in T₄ (Stale seed bed + reduced spacing up to 25% + mulching with paddy straw + one hand weeding) in which row to row spacing reduced in 25%.

Table 1: Treatment details

S. No	Treatment	Symbol used
1.	T ₁ Two hand weeding 40 and 80 DAS	T ₁
2.	T ₂ -one HW at 40 DAS + one weeding at 80 DAS	T ₂
3.	T ₃ Inter cropping with mustard in 3:1	T ₃
4.	T ₄ Stale seed bed + reduced spacing up to (25%) + mulching with paddy straw + one HW	T ₄
5.	T ₅ Locally available weed mulch + 1 hand weeding at 40 DAS	T ₅
6.	T ₆ Incorporation of mustard oil cake 15 days before sowing @ 5 t/ha +1HW at 40 DAS	T ₆
7.	T ₇ weed control practices by farmers as mulching with mango leaves	T ₇

Results and Discussion

The plant population of garlic was recorded at 20 DAP and at harvest stage have been given in Table-2. The lowest plant population of garlic 27.33 plant/m² at both the stages were noted in T₃ in which 25% rows of garlic were replaced by mustard rows (3:1). Similarly maximum number of garlic plants 55/m² was noted in T₄ (Stale seed bed + reduced spacing up to (25%) + mulching with paddy straw + one HW) where row to row spacing was reduced by 25%. The plant population in other treatments varied from 41 to 43 plants/m² which was not affected significantly under different weed control treatment. Plant height of garlic at different stages of growth have been given in Table-2. After perusal of data it is clear that plant height of garlic was affected significantly at different stages of growth. Plant height of garlic at 40 DAP varied from 11.57 to 14.05 cm under different weed control practices and maximum plant height 14.05 cm was noted under T₄ (Stale seed bed + reduced spacing up to (25%) + mulching with paddy straw + one HW). Significantly lowest plant height was noted under two hand weeding. Plant height of garlic at 80 DAP has been given in Table-2 reveals that plant height 41.31 cm was under T₆ where mustard oil cake was Incorporated @ 5 t/ha along with one hand weeding followed by T₅ (Locally available weed mulch + 1 hand weeding at 40 DAP). Similar trends at 120 and 160 DAP were also noted. The rate of increase in plant height of garlic was

maximum from 80 to 120 DAP and maximum increase was noted upto 160 DAP there after it become constant. Plant height at harvest was significantly maximum 69.54 cm was observed in under T₄ where close row spacing was adopted followed by T₆ where mustard oil cake @ 5 t/ha along with one hand weeding were adopted as weed control practices. In other treatment plant height varied from 61.43 cm to 63.56 cm but the differences were not found significant under different weed control practices. Data pertaining to number of leaves per plant of garlic at different stages of growth have been given Table-2. Maximum number of leaves 5.2 per plant at 40 DAP was noted in T₃ (Inter cropping with mustard in 3:1) followed by 4.55 per plant in T₄ (Stale seed bed + reduced spacing up to (25%) + mulching with paddy straw + 1 HW at 40 DAP). These Treatment were at par and were significantly Superior than farmers practice of weed control as mulching with mango leaves (T₇). Other treatments were not affected significantly as Compared to farmers practice of mulching. The number of leaves / plants at 120 DAP was maximum 8.77 under two hand weeding at 40 and 80 DAP followed by 8.33 per plant in T₆ where mustard oil cake 5 t/ha along with one hand weeding were giving given as weed control practices in garlic. Similar trends in number of leaves per plant of garlic was also noted at 160 days after planting.

Table 2: Effect of weed management on plant growth parameter of garlic.

Treatment	Plant population/m ²		Plant height (cm)					Number of leaves per plant			
	20 DAP	At harvest	40 DAP (cm)	80 DAP (cm)	120 DAP (cm)	160 DAP (cm)	At Harvest (cm)	40 DAP	80 DAP	120 DAP	160 DAP
T ₁	41.33	41.33	10.47	30.51	53.44	64.56	64.56	4.15	5.55	8.77	8.88
T ₂	43.33	43.33	12.33	37.66	59.31	60.76	60.76	3.69	5.44	7.33	7.77
T ₃	27.33	27.33	12.40	37.68	51.52	63.36	63.36	5.20	5.51	7.44	7.88
T ₄	55.00	55.00	14.05	31.02	53.90	65.54	65.54	4.55	5.77	7.55	7.77
T ₅	43.20	43.20	12.71	38.50	51.69	62.90	62.90	4.02	6.00	7.00	7.44
T ₆	41.10	41.10	11.57	41.31	56.07	67.17	67.17	4.15	6.22	8.33	8.66
T ₇	41.33	41.33	12.23	34.91	59.97	61.43	61.43	4.03	5.59	7.22	7.22
S.Em±	1.46	1.46	0.43	1.29	0.69	0.72	0.72	0.32	0.32	0.22	0.25
CD at 5%	4.32	4.32	1.27	3.81	2.03	2.14	2.14	0.94	0.94	0.65	0.73

Table 3: Effect of weed management on yield parameter of garlic

Treatment	Bulb weight/ plant (g)	Number of cloves/ bulbs	Weight of single clove (g)	Bulb yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T ₁	23.55 (124.71%)	18.29 (53.18%)	1.28	66.03 (316.06%)	20.67 (250.33%)	74.61	144480	264040	119560	1.82
T ₂	18.90 (80.34%)	16.21 (35.76%)	1.16	55.53 (249.90%)	22.52 (281.69%)	69.28	125630	222040	96410	1.76
T ₃	7.58 (-27.67%)	11.92 (-0.16%)	0.63	14.93-G (-5.92%) 9.45-M	6.79 (15.08%)	68.73	110511	97440	-13071	0.88
T ₄	20.29 (93.60%)	15.69 (31.40%)	1.29	63.75 (301.70%)	27.02 (357.97%)	72.09	120510	254800	134290	2.11
T ₅	10.85 (3.53%)	12.94 (8.37%)	0.88	43.17 (172.02%)	21.19 (259.15%)	70.74	123610	172480	48870	1.39
T ₆	26.89 (156.58%)	23.25 (94.73%)	1.05	93.68 (490.29%)	31.43 (432.37%)	72.88	215300	375200	159900	1.74
T ₇	10.48 (00.00)	11.94 (00.00)	0.85	15.87 (00.00)	5.90 (00.00)	73.23	121200	63480	-57720	0.52
S.Em±	0.46	0.52	0.05	3.23	1.85	0.56				
CD at 5%	1.35	1.54	0.15	9.53	5.45	1.66				

After harvest of garlic Samples plant were air dried in the shade thereafter bulb weight has been recorded which is given in Table-3. Maximum bulb weight 26.89 g per plant was noted under the application of 5 t/ha mustard of cake + One HW given in T₆ followed by 23.55 g per plant under two hand weeding at 40 and 80 DAP given as weed control in T₁ and T₄ (Stale seed bed + reduced spacing up to (25%) + mulching with paddy straw + one HW). These treatments give 93.6% to 156.58% higher bulb weight per plant as compare to farmers practice of Mulching. Lowest bulb weight 7.58 g per plant was noted under intercropping of garlic with mustard in (3:1) where bulb yield of garlic reduced by 27.67% over farmers practice of Mulching. One hoeing at 40 DAP and one HW at 80 DAP give bulb weight 18.9 g/ plant which was Superior than T₇, T₃ and T₅. Treatment T₂ (One HW at 40 DAP + One weeding at 80 DAP) also gave 80.34% higher bulb yield per plant over farmers practice of mulching. After separating the Cloves from bulb, it was counted which has been given in Table-3. Significantly maximum number of Cloves 23.25 / bulb was noted when mustard oil cake 5 t/ha along with one HW was given as weed control practices in T₆ followed by 18.29 Cloves/bulb in Two hand weeding at 40 and 80 DAP (T₁), 16.21 Cloves/ bulb in T₂ (One hoeing at 40 DAP + One weeding at 80 DAP) and 15.69 Cloves/bulb in T₄ (Stale seed bed + reduced spacing up to (25%) + mulching with paddy straw + one HW). This treatment gave 31.4% to 94.73% higher number of Cloves/bulb than farmers practice of mulching with mango leaf (T₇). Number of Cloves per bulb was reduced by 16%, in T₃ (Inter cropping with mustard in 3:1) as Compare to farmers practice of mulching. Weight of 10 cloves has been recorded and average value has been given in Table-3 which reveals that weight of Single clove was affected significantly under different weed Control practices. Maximum clove weight 1.29 g was noted in T₄ (Stale seed bed + reduced spacing up to (25%) + mulching with paddy straw + one HW) followed by 1.28 g / clove in T₁ (Two hand weeding 40 and 80 DAP) and 1.16 g/clove in T₂ (One hoeing at 40 DAP + One weeding at 80 DAP). Application of mustard oil Cake 5 t/ha along with one

hand weeding in T₆ gave 1.05 g weight/clove. Lowest clove weight 0.63 g /clove was reported in T₃ (Inter cropping with mustard in 3:1) followed by 0.85 g per clove in farmers practice of mulching (T₇). Bulb yield of garlic under different weed control practices in organic production System. After one week shade drying has been recorded which have been presented in table-3. Incorporation of mustard oil cake 5 t/ha and with one HW (T₆) gave maximum bulb yield 93.68 q/ha which was significantly superior than rest of the weed control practices given in garlic under organic production system. This treatment gave 490.29% higher bulb yield than farmers practice of mulching. Two hand weeding at 40 and 80 DAP (T₁) gave bulb yield 66.03 q/ha which gave 316.06% higher bulb yield over farmers practice of mulching followed by stale seed bed + reduced spacing (25%) + mulching + one hand weeding gave bulb yield 63.75 q/ha. These treatments were as par but inferior than T₆ (incorporation of mustard oil cake @ 5 t/ha +1HW at 40 DAP). Intercropping of mustard with garlic gave only 14.93 q/ha bulb yield in which bulb yield was reduced by 5.92% over farmers practice but it also gave 9.45 q/ha Mustard seed yield. Straw yield of garlic was taken after separating the bulb which is given in Table-3. The straw yield varied from 5.9 q/ ha to 31.43 q/ha under different weed control practices. Straw yield 31.43 q/ha was maximum under incorporation of mustard oil cake 5 t/ha + one HW which gave 432.37% higher straw yield as compared to farmers practice of mulching. Stale seed bed + reduced spacing + mulching + 1 HW gave straw yield 27.02 q/ha which was 357.97% higher than farmers practice T₇. One hoeing at 40 DAP + one HW at 80 DAP (T₂) gave straw yield 22.52 q/ha which was at par to two hand weeding 40 and 80 DAP but this treatments gave 250.33% to 281.69% higher straw yield than farmers practice of mulching. Harvest index of garlic under the influence of different weed Control practices under organic production system has been presented in Table-3 and value of HI varied from 68.73% to 74.61% under different weed Control practices. Maximum harvest index 74.61% was noted under two HW at 40 and 80 DAP (T₁) followed by 73.23% in T₇

(ITK treatment on weed control practiced by farmers as mulching with leaf of mango) and 72.83% in T₆ (incorporation of mustard oil cake @ 5 t/ha + 1HW at 40 DAP). These treatments were statistically at par but superior than T₅ (locally available weed mulch + one HW at 40 DAP), T₃ (Inter cropping with mustard in 3:1) and T₂ (one hoeing at 40 DAP + One weeding at 80 DAP). Cost of cultivation, gross return and net return of garlic under different weed control practices in organic production system have been given in Table-3. Cost of cultivation varied from Rs 110511 to Rs 215300 per hectare under different weed control. Maximum cost of cultivation rupees 215300/ha was calculated for incorporation of mustard oil cake @ 5 t/ha + one HW giving in garlic as weed control practices. Gross return of different weed control practices applied in garlic under organic production system revealed that maximum gross return rupees 375200 / ha was noted under application of mustard oil cake @ 5 t / ha + one HW given as weed control in garlic followed by rupees 264040/ha under two HW at 40 and 80 DAP applied as weed Control practices in garlic in T₁ and rupees 254800/ha in T₄ (stale seed bed + reduced spacing 25% + mulching + one hand weeding). Lowest gross return rupees 97440 /ha was noted under intercropping of garlic with mustard in 3:1 (T₃). One hoeing at 40 DAP + one weeding at 80 DAP gave gross return rupees 222040 /ha which was also higher as compare to T₃ (Inter cropping with mustard in 3:1), T₅ (locally available weed mulch + 1 HW at 40 DAP) and farmers practice of mulching in T₇. Net return of different weed control practices in applied in organically grown garlic revealed that maximum net return rupees 159900/ha was noted under incorporation of mustard Oil Cake @ 5 t/ha + one HW followed by 134290/ha in T₄ (stale seed bed + reduced spacing (25%) +

mulching + one hand weeding) and rupees 119560/ha under two HW at 40 and 80 DAP (T₁). Other treatments gave inferior net return as compare to above treatments. Net return was negative in T₃ (Inter cropping with mustard in 3:1) and T₇ (ITK treatment on weed control practiced by farmers as mulching with leaf of mango). Benefit cost ratio of garlic under different weed control practices in organic production system has been given in Table-3 reveals that maximum BC Ratio 2.11 was noted in T₄ where stale seed bed + 25%. reduced spacing + mulching + HW was given as weed control practices followed by 1.82 in T₁ (two HW at 40 and 80 DAP) and 1.76 in T₂ (one hoeing at 40 DAP + one weeding at 80 DAP). Intercropping of garlic with mustard in T₃ and weed control practices by farmers as mulching with mango leaf gave BC ratio below one.

Table 3: Different weed species/m² in farmers practice (T₇) at 100 DAS of garlic field.

Weed species	Intensity/m ²
<i>Medicago hypsida</i>	61.21
<i>Phalaris minor</i>	17.29
<i>Chenopodium album</i>	14.71
<i>Vicia sativa</i>	4.59
<i>Anagallis arvensis</i>	4.24
<i>Heliotropium indium</i>	2.17

The major weeds found in garlic field under farmers practice of mulching in organically grown garlic were *Heliotropium indicum*, *Chenopodium album*, *Medicago hypsida*, *Vicia sativa*, *Phalaris minor* and *Anagallis arvensis*. The dominating weeds was *Medicago hypsida* (61.21 /m²) and *Phalaris minor* (17.29 weeds /m²).

Table 4: Average weed intensity /m² in garlic at 100 DAS under different weed control practices in organic production system.

Treatment	<i>Heliotropium indicum</i>	<i>Chenopodium album</i>	<i>Medicago hypsida</i>	<i>Vicia sativa</i>	<i>Phalaris minor</i>	<i>Anagallis arvensis</i>	Total weed population/m ²
T ₁	3.41 (1.97)	7.33 (2.79)	43.02 (6.60)	3.35 (1.96)	16.12 (4.07)	6.16 (2.58)	79.39 (8.93)
T ₂	4.66 (2.27)	10.78 (3.35)	42.51 (6.65)	7.15 (2.76)	8.21 (2.95)	3.25 (1.93)	76.2 (8.75)
T ₃	4.47 (2.22)	3.25 (1.93)	42.11 (6.52)	10.11 (3.25)	11.12 (3.40)	6.22 (2.59)	77.28 (8.81)
T ₄	5.12 (2.38)	24.10 (4.96)	60.12 (7.78)	7.14 (2.76)	18.15 (4.31)	3.31 (1.95)	112.94 (10.65)
T ₅	2.22 (1.64)	5.17 (2.38)	46.21 (6.83)	4.33 (2.19)	10.17 (3.26)	3.20 (1.92)	71.3 (8.47)
T ₆	4.03 (2.12)	8.32 (2.96)	44.71 (6.72)	3.71 (2.05)	21.71 (4.71)	2.57 (1.75)	85.05 (9.24)
T ₇	2.17 (1.63)	14.71 (3.9)	61.21 (7.85)	4.59 (2.25)	17.29 (4.21)	4.24 (2.18)	104.21 (10.23)
S.Em±	0.43	0.62	1.02	0.45	0.74	0.28	
CD at 5%	1.26	1.84	3.02	1.33	2.18	0.82	

Figure in parenthesis is square root transformed value $y = \sqrt{x} + 0$

Data pertaining to different weed intensity in garlic under organic production System have been given in Table-4. After perusal of the data, it is clear that different weed species differed Significantly in various weed control practices. *Heliotropium indicum* and *Chenopodium album* were dominating weed in T₄, *Medicago hypsida* was dominating weeds in T₇ (ITK treatment on weed control practiced by farmers as mulching with leaf of mango). *Vicia sativa* was dominating weed in Inter cropping of garlic with mustard while *Phalaris minor* was dominating weeds under the application of mustard oil Cake + One HW (T₆). Other weeds like *Anagallis arvensis* was dominating weed in Two HW at 40 and 80 DAP. Total weed intensity 112.94/m² was maximum in T₄ followed by farmers practice of mulching in T₇.

Conclusion

Growth, yield attributes and yield of rice was maximum under two hand weeding at 25 and 50 DAT followed by incorporation of mustard oil cake @ 5 t/ha+1 HW. These treatments gave

57.25% to 74.35% higher grain yield of rice over farmers practice of mulching with mango leaves. Garlic yield was maximum 143.76 q/ha under incorporation of mustard oil cake @ 5 t/ha+1 HW which gave 142.43% higher yield as compared to farmers practice of mulching. Two hand weeding at 25 and 50 DAP gave 109.86 q/ha bulb yield which was 85.26% higher than farmers practice of mulching with mango leaves. *Fimbristylis dichotoma* was most dominating weeds in rice followed by *Monochoria vaginalis*. Weed control efficiency 53.5% was maximum under Incorporation of mustard oil cake @ 5 t/ha+1 HW followed by 46.91% under Two hand weeding at 25 and 50 DAT. *Medicago hypsida* was most dominating weeds in garlic field. Weed control efficiency 55.15% was maximum in T₆ (Incorporation of mustard oil cake @ 5 t/ha+1 HW) followed by 45.87% in two hand weeding at 25 and 50 DAP. The net profit Rs 225471/ha with B:C ratio 2.22 was maximum under Two hand weeding at 25 and 50 DAT followed by Rs 168472 /ha and B:C ratio 1.53 under Incorporation of mustard oil cake @ 5

t/ha+1 HW. All other weed control practices were found inferior than above practices of weed control. Organic carbon, available nitrogen and phosphorus status were reduced under all the weed control practices in organically grown rice-garlic cropping system. Available potash status has been increased under all the weed control practices except two hand weeding at 25 and 50 DAP.

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