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To study the performance of various weed management practices on growth and yield of *rabi* tomato (*Solanum lycopersicum* L.) under organic production system

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Abstract
A field experiment was conducted in the experimental plots of Instructional Cum Research Farm, I.G.K.V., Raipur, Chhattisgarh, during *rabi* season of the year 2019. Design of experiment was RBD with three replications. The soil of the experimental field was vertisols and climate was dry sub-humid climate with annual rainfall between about 1200 and 1400 mm. The objectives of experiment were to the study the performance of various weed management practices on growth and yield of *rabi* tomato under organic production system. The treatments constituted with nine weed management W1(Hand weeding at 20, 40, 60 and 80 DAT), W2 (Mechanical weeding twice at 20 and 40 DAT + one hand weeding at 60 DAT), W3 (Intercropping with cowpea 1:1), W4 (Stale seed bed + reduced spacing upto (25%)+ mulching with paddy straw + one hand weeding at 20 DAT) and W5 (Weed mulching + one hand sweeding at 20 DAT), W6 (Incorporation of neem cake 15 DBT @ 5 tonnes/ha + one hand weeding at 20 DAT), W7 (Two hand weeding at 20 and 40 DAT, W8 (Mulching with waste polythene bags (ITK)), W9 (Weedy check). As regards to the effect of various weed management practices the stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20, 40, 60 and 80 DAT treatment showed maximum weed control efficiency and minimum weed index. The yield was positively related to percent reduction of weed density, biomass and weed control efficiency. The highest net return was obtained under mulching with waste polythene bags (ITK-practices) and the highest B:C ratio was computed under stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20, 40, 60 and 80 DAT. However, the highest gross return was incurred in stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20 DAT.

Keywords: Mulching, straw mulch, tomato, stale seed bed, neem cake

Introduction
Tomato (*Solanum lycopersicum* L.) is a widely grown vegetable which ranks next to potato in vegetable production worldwide. It is a major source of minerals and antioxidants such as carotenoids, lycopene, vitamin C, E and phenolic compounds (Adalid *et al.*, 2004) [1], and thus plays a key role in human nutrition. Produce. Tomato consumption is known for avoiding many cancers and cardiovascular diseases (Frusciante *et al.*, 2007) [5]. World tomato production was approximately 105 million tons of fresh fruit in 2001, from an estimated 3.9 million ha. As it is a relatively short-lived crop and yields high, it is economically attractive and the area under cultivation continues to increase daily. This vegetable extensively grown in Andra Pradesh, Karnataka, Madhya Pradesh, Odisha and Gujarat. Presently, tomato grown in area of 879 thousands hectare with the production of 18226 thousands MT (National Horticultural Board, 2013).

Mulching is one such alternative, nonchemical, and environmentally friendly weed control strategy. Mulches are any material that covers the soil's surface which protects the soil from erosion, adds organic matter and suppresses weeds. Mulches are an organic mulch (living or dead plant material) of various forms, and an inorganic mulch (any non-living thing other than plant material). Organic mulch contains leaves, barks, newspaper shredding, woodchips, lawn cutting, etc. In these organic matters, mulching preserves the nutrients contained (Pouryousef *et al.*, 2015) [7].

In India the tomato is grown in an area of 767.3thousand hectare with a production and productivity of 16385 thousand MT and 21.3 MT/ha respectively (Anonymous, 2016). The major tomato producing states are Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh and West Bengal.

In Chhattisgarh the total area of tomato is 63.29 thousand hectare with a total production of 1087.33 thousand MT. (Anonymous, 2018) [4].

Table 1: In Chhattisgarh, tomato is grown in area and production of districts

S. No.	Districts	2016-17 (Area in '000 Ha Production in '000 MT)	
		Area	Production
1	Durg	9.51	190.15
2	Bilaspur	7.88	97.59
3	Jashpur	5.30	80.03
4	Raipur	4.29	76.39
5	Mahasamund	2.21	70.85
6	Bemetara	2.65	66.26
7	Mungeli	2.00	65.05
8	Raigarh	3.60	56.25
9	Balod	2.10	54.00
10	Janjgir-Champa	2.25	45.94

***Source*:** Horticultural Statistics at a Glance 2018, page. 314.

Mulching prevents the pattern of the disease triangle in the production of tomatoes (*S. Lycopersicum L.*) by reducing weed invasion, preventing weed germination, promoting clean field sanitation, stabilizing the soil regime by improving soil moisture, promoting better root growth, improving anchorage, improving water and nutrient absorption, improving organic matter (organic mulch) content and reducing weed.

2. Materials and Methods

2.1 Study Site Description

The field experiment was conducted at Instructional Cum Research Farm, I.G.K.V., Raipur (C.G.), Chhattisgarh during *rabi* season, 2019. Experimental site was situated at 21°4' N latitude, 81°39' E longitude and 298 meters above sea level, in the period 2019-20. The experiment was conducted during Rabi season, November, 2019 to April, 2020.

2.2 Experimental details

The field experiment was conducted in randomized block design with three replications. The experimental soil was classified as "Vertisol" in texture locally called as "Kanhar." It is deep, and therefore has a high capacity to hold water. Treatments constituted with nine weed management W1 (Hand weeding at 20, 40, 60 and 80 DAT), W2 (Mechanical weeding twice at 20 and 40 DAT + one hand weeding at 60 DAT), W3 (Intercropping with cowpea 1:1), W4 (Stale seed bed + reduced spacing upto (25%)+ mulching with paddy straw + one hand weeding at 20 DAT) and W5 (Weed mulching + one hand sweeding at 20 DAT), W6 (Incorporation of neem cake 15 DBT @ 5 tonnes/ha + one hand weeding at 20 DAT), W7 (Two hand weeding at 20 and 40 DAT, W8 (Mulching with waste polythene bags (ITK)), W9 (Weedy check).

2.3 Cultivation details

2.3.1. Raising of seedling in nursery bed

The seedlings were taken up for transplantation in the nursery. The raised beds of 2.5 m x 1.5 m x 0.15 m were prepared and 15 kg FYM were thoroughly mixed in the soil to each bed. In the first week of October 2019 the tomato seeds were sown on the raised beds by line sowing, holding a gap of 10 cm between two successive rows.

2.3.2 Field preparation

The experiment field was tilled twice with tractor-driven cultivar followed by rotating to bring the fine tilth to the soil. Minor bonds were made around each plot and replications during preparation of the layout. The land within the plots was levelled to allow uniform irrigation. The manual transplanting of tomato was performed on the well prepared plots as per the pattern.

Table 2: Field operation schedule during the crop season

S. No.	Cultural schedule	Operation methods	Date
1	Field preparation a) Layout and bunds preparation	1) Ploughing (tractor) a. 1st ploughing b. 2nd ploughing c. Rotavator (tractor) and layout manually	10-10-2019 11-10-2019 12-10-2019
2	Application of Neem cake as per treatment	Manual	17-10-2019
3	Transplanting and Organic manure application	Manual	1-11-2019
4	Gap filling	Manual	15-11-2019
5	Hand weeding as per treatment	Manual	20 DAT, 40 DAT, 60 DAT, 80 DAT
6	Mechanical weed as per treatment	Cycle hoe	20DAT, 40DAT
7	Straw mulch as per treatment	Manual	15-11-2019
8	Weed mulch	Manual	15-11-2019
9	Waste polythene bag mulch	Manual	1-11-2019
10	Picking of fruits	Manual	3 times

2.3.2.2 Application of organic manure

Before application of organic manures in the field, chemical analysis of FYM, vermicompost and poultry manure was performed to determine the content of organic materials. The N, P and K material added through the organic sources is given in table 3

Table 3: Average N, P and K content (%) of various organic sources

S. No.	Organic source	N	P	K
1.	FYM	0.67	0.26	0.44
2.	Vermicompost	1.6	0.6	1.0
3.	Neem cake	1.33	0.3 to 0.5	0.81

All the above mentioned organic source of nutrients were applied as per the treatment in their respective plots to fulfil the nutrients requirements of tomato i.e. 180:100:60 kg N:P2O5:K2O ha^{-1}.

2.4 Observations recorded

In high population climatic conditions, plant height is reflective of competition for light and dependent on intra- and inter-specific competition. The data on plant height were recorded from the ground level to the top of the main stem with the help of a measuring tape. At the early stage of fruiting, measurements were taken from randomly selected five plants per plot. The total number of primary branches of five randomly selected plants was counted, and workout average. The total number of secondary branches of five randomly selected plants was counted, and workout average. The dry weight (g) of five randomly selected plants of each and every treatment replication was observed, and average dry weight of the plant was measured. Number of fruit per plant was recorded as five randomly selected plants per plot were counted on the total number of fruits present at maturity, and their average was calculated in each plot. Fruit data were recorded by weighing all the mature fruits present on five randomly selected plants per plot, and their average mean was calculated in each plot. The weight of fruits of five selected plants was recorded at each picking and the total weight of fruits was calculated by cumulative harvest in kilograms, which was averaged over replications. Adigun (2005) noticed that weed infestation throughout the crop life cycle resulted in about 40 to 60 percent reduction in potential tomato fruit yield compared with the maximum yield obtained in each trial. The fruit yield in q/ha was worked out with the help of the following formula:

$$\text{Fruit yield (q/ha)} = \frac{\text{Weight of fruit (kg per plot)}}{\text{Net plot area (sq.m.)}} \times \frac{1000}{100}$$

The observation of weeds

1. Density of weed to be observed that the number of weeds present in 0.25 m^2 area at four marked places was counted at 20,40,60, and 80 days after transplantation (DAT) and harvesting in each plot. Before they were introduced to statistical analysis they were further categorized into their species.
   Ved prakash and shivastava (2006) [6] reported that weed competition caused yield losses in tomatoes the extent of 5.3, 26.9, 46.9, 49.2, 52.0 and 54.9 percent when it existed for 15, 30, 45, 60, 75 days from transplanting and at harvest respectively.
2. Dry weight of weeds was recorded at 20, 40, 60 and 80 DAT and at harvest. The weeds were collected from the selected random area of 0.25 m^2 at each time and dried oven to a constant weight at 75°C. At each point, the weight of dried weeds from the oven was registered.
3. Weed control efficiency (WCE) was calculated by using the formula given by Patel *et al.* (1987) and expressed in percentage

$$\text{WCE (\%)} = \frac{\text{DMC- DMT}}{\text{DMC}} \times 100$$

DMC = Dry weight of weeds under control plot
DMT = Dry weight of weeds under treated plot.

3. Results and Discussion

The result of the effect of different mulches on the yield and yield contributing characters are presented in

3.1 Plant population of tomato at various durations

The observations taken during the initial stages (20 DAT) under no significant difference was observed at the initial stages of different weed management practices. However at the final stage the maximum population was obtained under W4: Stale seed bed + reduced spacing (upto25%) + mulching with paddy straw + one hand weeding at 20 DAT with values of 10.72 while the lowest was obtained under weedy check with 5.67. Shuaib (2001) [11] reported that the period between 15 to 30 days after transplanting was the critical period of crop-weed competition in tomatoes.

3.2 Plant height of tomato

The observations taken during the initial stages (20 DAT) were not significantly different from each other. At 40 DAT, 60 DAT and 120 DAT condition, the maximum heights were under the polythene bag with 83.71 cm, 87.10 cm and 104.37 cm respectively. While lowest was under the weedy check with 53.85 cm, 64.06 cm and 72.57 cm respectively. The at par values were obtained under paddy straw, mechanical and hand weeding at 40 DAT, under paddy straw at 60 DAT. At 120 DAT, the at par values were obtained under neem cake, hand weeding and paddy straw. Reddy *et al.*, (2000) [10] noticed that the fruit yield of brinjal in the plots treated with butachlor, pendimethalin, metachlor, alachlor, each at 1.0 kg/ha or oxyfluorfenat 0.10 kg/ha. Hand weeding at 40 days after sowing was equivalent with weed free control and was significantly higher compared to application of herbicides at higher level.

3.3 Dry matter accumulation $plant^{-1}$

The highest observations were recorded under hand weeding at 20 DAT (15.88 g), the lowest values were recorded under weedy check at 40 DAT, 60 DAT and at harvest with values at 21.96, 24.36 and 32.85 g respectively. Rana and Barevadia (1995) observed that the highest fruit yield 52.68 t/ha was obtained with pendimethalin + hand weeding.

3.4 Number of primary branches $plant^{-1}$

The number of primary branches per plant were not significantly different under different weed management conditions. The highest observations were under polythene bag at 40 DAT (10.2), 60 DAT (9.0) and at harvest (11.73). The lowest values were under weedy check 40 DAT (7.07), 60 DAT (6.13) and at harvest (8.53).

3.5 Number of secondary branches $plant^{-1}$

At all durations, the maximum number of branches were recorded under polythene bag practice while the lowest number of branches were under weedy check.

3.6 Number of flowers per cluster

At all durations, the maximum number of branches were recorded under polythene bag practice while the lowest

number of branches were under weedy check.

3.7 Number of fruits per cluster
At all durations, the maximum number of fruits per cluster were recorded under polythene bag practice while the lowest number of fruits per cluster were under weedy check.

3.8 Number of fruits per plant
The maximum number of fruits at all durations per cluster were recorded under polythene bag practice while the lowest number of fruits per cluster were under weedy check.

3.9 Average fruit weight of tomato
Average fruit weight was highest under polythene bag and lowest under weedy check during all the three observations.
Fruits yield of tomato: The maximum total fruit yield at all durations were recorded under paddy straw application giving a total of 497.57 q/ha while the lowest number of total fruit yield was under weedy check giving only 88.5 q/ha.

Table 4: Effect of yield and yield contributing parameters of tomato at various durations as influenced by different organic weed management

Treatments	Plant height (cm)	Dry matter accumulation plant^{-1} (g)	Number of primary branches plant $^{-1}$	Number of secondary branches plant^{-1}	Number of flowers cluster $^{-1}$	Number of fruits cluster^{-1}	Number of fruits per plant	Average fruit weight plant^{-1} (g)	Total fruit yield (q/ha)
W1- Hand weeding at 20,40, 60 and 80 DAT	92.58	59.27	10.67	31.08	18.6	12.48	19.40	25.55	382.24
W2- Mechanical weeding twice at 20 and 40 DAT + one hand weeding at 60 DAT	88.59	57.83	10.13	28.53	17.96	11.69	18.93	26.84	322.54
W3- Intercropping with cowpea (1:1)	76.89	40.42	8.80	19.80	15.06	9.28	16.92	21.15	122.39
W4- Stale seed bed + reduced spacing (upto25%) + mulching with paddy straw + one hand weeding at 20 DAT	90.60	58.51	10.47	30.77	17.99	11.90	19.07	23.62	497.57
W5- Weed mulching + one hand weeding at 20 DAT	79.18	40.29	9.42	19.87	15.54	9.80	17.19	22.18	151.88
W6- Incorporation of neem cake 15 DBT @ 5 tonnes/ha + hand weeding at 20DAT	97.59	43.84	9.93	21.00	16.63	10.96	18.43	23.54	211.26
W7- Two hand weeding at 20 and 40 DAT	83.11	40.88	9.83	20.67	15.9	10.27	18.80	22.53	198.58
W8- Mulching with waste polythene bags (ITK)	104.37	65.88	11.73	34.07	20.07	13.20	21.42	30.32	412.24
W9- Weedy check	72.57	32.85	8.53	18.62	13.22	8.16	14.08	21.66	88.5
S.Em±	4.69	2.44	0.51	1.54	0.96	0.58	0.86	1.49	12.07
CD (P=0.05)	14.05	7.33	1.54	4.62	2.89	1.73	2.59	4.46	36.18

3.10 Weed density (no.m^{-2})
All weeds have the lowest density under the use of polythene bags corresponding to the value of 73. The highest value 266.6 is observed under the weedy check. Rajkumara *et al.*, (2010) [8] observed that weedy check throughout the crop period accumulated dry weed biomass of 8704 kg/ha which resulted in uptake of 141.52 kg/ha of nitrogen.

3.11 Weed dry weight (g $^{-m-2}$)
The total weed dry weight was lowest under the use of polythene bags and was highest under weedy check. Tolman *et al.*, (2008) [12] observed that average yield losses due to weeds alone approached 80% in tomato and 60% in cabbage.

3.12 Weed control efficiency (%)
The weed control efficiency was highest in the case of polythene bag at all durations while it was least in the case of weedy check. Zhang (1992) [15] reported that black plastic mulch resulted in 100 percent control of all weeds in tomato, whereas silver lustred thin film resulted in 92 percent control of graminaceous weeds. Black and silver lustred film mulch resulted in increased tomato yields of 27.71 and 15.00 percent when compared to transparent film.

3.13 Weed growth rate
The weed growth rate was high at all times under the weedy check except for 0 – 20 DAT which shows highest growth under the mechanical weeding. However, the least growth rate was observed under hand weeding at 20 – 40 DAT with the value of – 0.95. Tumbare and Ilhe (2004) reported that, *Panicum isachmi, Cyperus rotundus, Lyndon dectylon, Eragrostis major, Euphorbia geniculata, Amaranthus viridid and Lagasca mollis,* were the major weeds associated with tomato crop in sandy clay loam soils of Rahuri.

3.14 Weed index (%)
The weed index of tomato is under is lowest under W4- Stale seed bed + reduced spacing (upto25%) + mulching with paddy straw + one hand weeding at 20 DAT. Weedy check has the highest weed index of 82.21. Khalak and kumarswamy (1993) [6] reported that the mulching with straw and polythene reduced total weed dry weight and increased the potato tuber yield to 16.7 tons/ha, respectively. Mulching with straw was superior to polythene in terms of incremental cost benefit ratio.

Table 5: Effect of different weeds in tomato at various durations as influenced by different organic weed management

Treatments	Weed density (no.m^{-2})		Weed dry weight (g $^{-m-2}$)		Weed control efficiency (%)		Weed growth rate (g^{-} $^{day-m-2}$)		Weed index (%)
	20 DAT	At harvest	20 DAT	At harvest	20 DAT	At harvest	20 DAT	At harvest	
W1- Hand weeding at 20,40, 60 and 80 DAT	209.92	97.01	39.88	21.34	5.03	89.45	1.99	-0.07	23.18
W2- Mechanical weeding twice at 20 and 40 DAT + one hand weeding at 60 DAT	216.42	125.34	40.79	33.57	2.86	83.41	2.04	0.5	35.18
W3- Intercropping with cowpea (1:1)	153	199.34	26.01	133.86	38.06	33.84	1.3	1.35	75.40

W4- Stale seed bed + reduced spacing (upto25%) + mulching with paddy straw + one hand weeding at 20 DAT	107.8	133.67	18.32	56.14	56.37	72.25	0.92	0.51	-
W5- Weed mulching + one hand weeding at 20 DAT	155.8	184.34	26.48	115.55	36.94	42.89	1.32	1.53	69.48
W6- Incorporation of neem cake 15 DBT @ 5 tonnes/ha + hand weeding at 20DAT	172.26	169.33	29.28	95.86	30.27	52.62	1.46	1.21	57.54
W7- Two hand weeding at 20 and 40 DAT	212.72	151.99	38.16	83.43	9.12	58.77	1.91	1.42	60.09
W8- Mulching with waste polythene bags (ITK)	48.99	73	9.79	20.79	76.68	89.73	0.49	0.15	17.15
W9- Weedy check	221.68	266.67	41.99	202.34	0	0	2.1	2.26	82.21
S.Em±	1.34	2.45	2.30	4.41	-	-	-	-	-
CD (P=0.05)	4.03	14.89	6.88	13.22	-	-	-	-	-

4. Conclusion

Among the effect of various weed management practices the significantly higher yield under the stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20 DAT which was found at par with mulching with waste polythene bags (ITK-practices), hand weeding at 20, 40, 60 and 80 DAT and mechanical weeding twice at 20 and 40 DAT+ one hand weeding at 60 DAT. As regards to the effect of various weed management practices the stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20, 40, 60 and 80 DAT treatment showed maximum weed control efficiency and minimum weed index which was followed by mulching with waste polythene bags mulch(ITK-practices), hand weeding at 20, 40, 60 and 80 DAT, and Mechanical weeding twice at 20 and 40 DAT + one hand weeding at 60 DAT weedy check has the highest weed index of 82.21. The yield was positively related to percent reduction of weed density, biomass and weed control efficiency. All weeds have the lowest density under the use of polythene bags corresponding to the value of 73. The highest value 266.6 is observed under the weedy check.

The highest net return was obtained under mulching with waste polythene bags (ITK-practices) followed by hand weeding at 20, 40, 60 and 80 DAT and stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20 DAT and the highest B:C ratio was computed under stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20, 40, 60 and 80 DAT. However, the highest gross return was incurred in stale seed bed + reduced spacing (up to 25%) + mulching with paddy straw + hand weeding at 20 DAT.

5. Reference

1. Adalid AM, Rosello S, Nuez F. Breeding tomatoes for their high nutritional value. Rec. Res. Dev. in Pl. Sci 2004;2:33-52.
2. Adigun JA. Chemical weed control in transplanted rainfed tomato (*Lycopersicum esculentum* Milli.). In the Forest- Savanna Transition zone of South Western Nigeria. ASSET- Series A: Agriculture and Environment 2002;2:2, 141-150.
3. Anonymous. Ministry of Horticulture and Farmers Welfare, Govt. of India. Horticultural statistics at a glance-2016, Table7.1.17: All India area, production and productivity of tomato 2016, 147.
4. Anonymous. Ministry of Horticulture and Farmers Welfare, Govt. of India. Horticultural statistics at a glance – 2018, Area, Production and Yield of Horticulture Crops, Table 7.3.34: State-wise Area and Production of Tomato 2018, 203.
5. Frusciante L, Carli P, Maria R, Ercolano S, Pernice R, Matteo AD *et al.* Antioxidant nutritional quality of tomato. Mol. Nutr. & Food Res 2007;51(5):609-617.
6. Khalak A, Kumaraswamy AS. Weed biomass in relation to irrigation and mulching and economic of mulching potato crop under conditions of acute water scarcity. Journal of Indian Potato Association 1993;20:185-189.
7. Pouryousef Reza AM, Yousefi Oveisi M, Asadil F. Intercropping of fenugreek as living mulch at different densities for weed suppression in coriander. Crop Protec 2015;69:60-64.
8. Rajkumara S, Palled YB, Hebsur NS, Koti RV, Basavaraja N, Khot AB. Nitrogen uptake and economics of rainfed drill sown onion (*Allium cepa* L.) + chilli (*Capsicum annum* L.)+ Cotton (*Gossypium herbaceam* L.) intercropping system under different weed free periods. Karnataka Journal of Agricultural Sciences 2010;23:4, 590-594.
9. Rana, HC, Barevadia TN. Efficacy of different herbicides on nutrient uptake by weeds and yield of tomato (*Lycopersicum esculentum* Milli.). Indian Journal of Environment and Toxicology 1995;5:2, 75-76.
10. Reddy CN, Reddy MD, Devi MP. Efficiency of various herbicides on weed control and yield of brinjal. Indian Journal of Weed sciences 2000;32:3/4, 150-152.
11. Shuaib OSB. Critical period for weed competition in tomatoes (*Lycopersicum esculentum* Milli.). University of Aden journal of Natural and applied Sciences 2001;5:1, 11-18.
12. Tolman JH, McLeod DGR, Harris CR. Cost of crop losses in processing tomato and cabbage in southwestern Ontario due insects, weeds and diseases. Canadian Journal of Plant Sciences 2008;84:3, 915-921.
13. Tumbare AD, Ilhe SS. Response of tomato to napropamide during rabi season. Indian Journal of Weed Science 2004;36(1, 2):153-154.
14. Ved Prakash, Srivastava K. Crop- weed competition studies in tomato (*Lycopersicum esculentum* Milli.) under Mid-hills of North-west Himalayas. Indian Journal of Weed Sciences 2006;38(1, 2):86-88.
15. Zhang BY, Chen HG, Zhout TW. Exploration on coloured plastic film mulch for controlling weeds in tomato nursery and main fields. Plant protection 1992;6:40-41.