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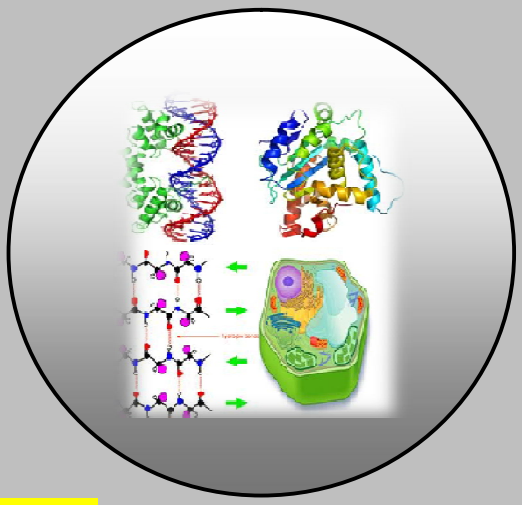

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RESEARCH PAPER

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Studies on the effects of Chlorpyrifos on Growth and Yield in Green Gram (*Vigna radiata* L.) at Different Phenological Stages

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ABSTRACT

Green gram (Vignaradiata (L.) Wilczek) is one of the most important pulse crops in the worldbut the farmers could not harvest expected yields due to the attack of uncontrollable pests. To overcome the hurdle and produce maximum yield, the farmers are repeatedly spraying various kinds of pesticides and plant protection chemicals amongst which Chlorpyrifos is the important one. It therefore seems important to test the changes that are occurring in this food crop under Chlorpyrifos treatments in order to identify the extent to which it tolerates the pesticide application thereby making it an economical food crop. 20 day old seedlings were exposed to different concentrations ranging from 50 ppm (Parts per million) to 150 ppm of Chlorpyrifos through foliar spray in the field condition. The seedlings were uprooted for analyses and observed at the pre flowering (5 days after treatment, DAT), flowering (10 DAT) and post flowering (20 DAT) stages for various morphological parameters such as plant height, number of branches, leaves per plant, total leaf area and plant biomass. Yield attributing characters such as number of pods plant^{-1}, number of seeds pod^{-1} and weight of 100 seeds were analyzed from both control and treated plants at maturity of plant. All the growth parameters and yield parameters increased at 50 ppm pesticidal treatment, when compared with control. Further increase in pesticide level had a negative impact upon all parameters studied. The data suggests that the application of Chlorpyrifos at lower concentration may be a useful tool to increase the seed quality as well as quantity in Green gram plant, apart from their pesticidal properties.

Key words: Pesticide, Mungbean, Stress and ppm.

INTRODUCTION

Pulses, the food legumes, have been grown by farmers since millennia providing nutritionally balanced food to the people of India and many other countries in the world (Nene, 2006). *Vigna radiata* (L.) Wilczek often known as green gram/mung bean, which belongs to the family Leguminoseae and sub family Papilionaceae, is native to India and Central Asia. It has been grown in these regions since prehistoric times and as an important legume crop in India throughout the year. Green gram (per100g) contains protein (24 %), carbohydrates (60%), fat (1.5%), phosphorus (0.326 %), iron (0.0073 %), carotene (0.00039 %), niacin (0.0021 %) and energy (334 cal)(Singh et al., 2009).Green gram is one of the most widely cultivated pulse crops after chickpea and pigeonpea. In India black gram is very popularly grown in Andhra Pradesh, Bihar Madhya Pradesh, Maharashtra, Uttar Pradesh, West Bengal, Punjab, Haryana, Tamil Nadu and Karnataka with an area of about 3.29 million ha with a total production of 1.60 million tones with an average productivity of 485 kg/ha.

A large number of different pest species have been observed infesting green gram crop throughout world and many of these frequently cause very appreciable damage to this crop, which is so essential to the diet of the population. About 128 species of insects have been reported attacking green gram from seedling stage up to pod formation stage. Among them, seed beetles (*Bruchuspisorum*), Leaf Weevils (*Apionaestivum*), Cutworms (*Agrotisipsion*), Pod borer (*Heliothisar migera*), Army worms (*Spodoptera exigua*) have gained importance in recent years. These pests cause damage to leaves and 22 to 49 % pod damage (Jakhmola and Singh, 1985).The debilitating impact of insects on seedling and seed production may be so great that remedial activity is desirable. Limiting crop losses requires an integrated approach that includes use of chemical pesticide. One such organophosphate pesticide, Chlorpyrifos (O, O-diethyl O-3, 5, 6-trichloro-2-pyridyl phosphorothioate), is extensively used in agriculture and forestry for its high activity against a broad spectrum of insect/pests. To the best of our knowledge, there is little information available so far about the effect of Chlorpyrifos especially on growth and yield of legumes. Keeping in view the importance of leguminous crops, the present investigation was carried out to find out the optimum level of Chlorpyrifos for efficient growth and yield of mungbean.

MATERIAL AND METHODS

Experimental set up and treatment

The seeds of *Vigna radiata* (L.) Wilczek were procured from Pulse research Centre, Indian Agricultural Research Institute (IARI), New Delhi. Field experiments were conducted in the month of June 2011 at the experimental field, Najibabad. The individual plot size was 6 m^2 (4 × 1.5 m) having 4 rows with a row to row distance of 15 cm and plant to plant distance of 10 cm. The number of plants per m^2 was 15. Twenty days-old seedlings were subjected to foliar application of three levels of Chlorpyrifos [50%, emulsifiable concentrate, (E.C.)], ranging from 50 ppm to 150 pm, prepared by dissolving the required amount of pesticide in double distilled water. Out of the total area, 1 m^2 of each plot was earmarked for the purpose of harvest analysis of seed yield parameters. The remaining rows (except border rows) were used for taking the periodic samples.

Seedlings were uprooted randomly at 5, 10 and 20 DAT that is at three developmental stages namely pre flowering, flowering and post flowering stages and then used for analysis of growth. Yield attributing character of mungbean was analyzed at maturity of the plant.

Growth parameters

Plant heights were measured in centimeters. Number of branches and leaves per plant were counted at three developmental stages. Leaf area was measured (in cm^2) by using a leaf area meter (3000A, LICOR, U.S.A). For plant biomass, the samples were oven dried separately at 80°C for 48 hr and dry weight (in mg) was determined on a digital weight balance (Kumar, 1981).

Yield attributing characters

Number of pods per plant, seeds per pod and weight of 100 seeds was counted at maturity of plant.

Statistical analysis

The mean value of ten plants were calculated as represented in the results applying statistical analysis Standard Deviation (± S.D.) and 't' test of significance at 5% level.

RESULTS

Low concentration of Chlorpyrifos (50 ppm) stimulated the growth performances of the plant. It increased plant height, number of branches, number of leaves, and total leaf area and plant biomass by 9.89, 12.27, 10.86, 10.11 and 7.19 % respectively at 20 DAT as compared to control. Whereas Seedlings treated with high concentrations of Chlorpyrifos (100 ppm and 150 ppm) showed significant decrease in plant height, number of branches, number of leaves, total leaf area and plant biomass. The magnitude of decrease in the abovementioned parameters was in accordance with the increasing concentration which wasupto12.6, 20.35, 23.88, 25.36 and 20.44% respectively under150 ppm Chlorpyrifos solution at 20 DAT [Table 1 (A-E)].

Similarly the seedlings which received lower concentration of Chlorpyrifos (50 ppm) exhibited increase in yield attributing characters like number of pods $plant^{-1}$, seeds pod^{-1} and weight of 100 seeds by 7.13, 24.39 and 23.17% respectively at maturity of plant. Quite the reverse number of pods $plant^{-1}$, seeds pod^{-1} and weight of 100 seeds were decreased at higher concentrations (100 ppm and 150 ppm) of Chlorpyrifos. The magnitude of decrease in the aforesaid parameters was in accordance with the increasing concentration which was upto24.77, 33.67 and 24.94 % respectively under the highest concentration used (150 ppm) at maturity of plant [Table 1 (F-H)].

DISCUSSION

Plant growth analysis is a necessary step in understanding the plant's performances and productivity. The present study showed that lower concentration (50 ppm) of Chlorpyrifos significantly proved highly effective, non-phytotoxic and seemed to elevate the growth parameters upto certain limit.

Nevertheless, it was at higher concentration that all the growth parameters namely plant height, number of branches, number of leaves plant^{-1}, total leaf area and plant biomass were remarkably reduced in all the growth phases under study. The studies of Kumar & Kumar (1993) indicate that the use of Metasystox on *Viciafaba* is promotory for seed germination and growth when used in lower concentrations (50-100 mg/l). The higher concentrations (200-300 mg/l) are, however, inhibitory for these parameters.

Our results are in consistence with the result of Bashir et al. (2007). They observed the effect of seed treatment by mancozeb on various morphological parameters in *Lens culinaris* L. in different developmental stage and concluded that all the morphological parameters increased significantly only at lower dose (0.1%) whereas a linear decrease with increasing concentrations of mancozeb was observed. In the experiment of Stevens et al. (2008), continuous exposure to imidacloprid (4 days at 2000 mg AI L-1) significantly reduced normal germination rate in rice plant. The lower dose of dimethoate (50 ppm) proved stimulant in growth for the same.

Suppression was noted in plant height under the higher concentration of applied pesticide which may be due to the retarded cell growth and division in root, cell elongation and conversion of indole-3 acetic acid (IAA) into various photooxidative products. Tevini and Teramura (1989) suggested that these compounds function as strong auxin antagonists. Another reason could be explained on the basis of inhibition in the activity of 4- hydroxyl phenyl pyruvate dioxygenase (HPPD), an enzyme needed for the growth and development of meristematic tissue as suggested by Luscombe et al. (1993) following pesticide isoxaflutole treatment in maize and sugarcane.

In the present study, this could be one of the reasons for growth ceasation in *Vigna radiata* L. The reduction in the number of leaves and leaf area, with an increasing concentration of Chlorpyrifos is observed. This is in agreement with the results recorded with bean leaves (Ruano et al., 1988). The reduced leaf area in stress conditions indicates not only retarded growth but possibly also a morphological adaptation to stress conditions. The same trend was observed in the number of branches in our study which was confirmed with the result of Khan et al. (2006) under the pesticidal (Methamidophos) treatment. In another study, Khan et al. (2006) concluded that disruption of certain metabolic pathways (Aromatic amino acid (AAA) biosynthesis by inhibiting ace to lactate synthase (ALS), the enzyme involved in the biosynthesis of amino acids) following herbicide exposure were the probable cause of growth and biomass inhibition in *Vigna radiata* L. This might be one of the reasons of decreased biomass in the present study.

Contrary to the results obtained at higher concentration of pesticide, low dose (50 ppm) of organophosphorous spesticide Chlorpyrifos significantly stimulated the growth performances of the seedling which is similar with the results obtained by application of other organophosphorous spesticide monocrotophos (Saraf and Sood, 2002). The possible cellular degradation of organophosphorous spesticide might have increased phosphate content that accelerated the growth at this dose of the tested pesticide.

In addition, low dose of pesticide probably increased the cell membrane permeability, thus enhanced nutrient influx to the root cells and their subsequent transportation to leaf and shoot.

Table 1. Variation in growth and yield attributes at various growth stages of *Vigna radiata* L. treated with different concentrations of Chlorpyrifos.

Parameters/ Stages	Chlorpyrifos (ppm)				Variation Over Control (%)		
	0	50	100	150	50 ppm (Values in +)	100 ppm (Values in -)	150 ppm (Values in -)
(A) Plant Height (cm. plant^{-1})							
5 DAT	34.45±1.88	38.78±0.98	30.29±0.76	25.01±1.34	12.57	12.08	27.40
10 DAT	58.32±2.96	60.05*±1.85	55.53±2.78	50.21±2.23	2.97	4.78	13.91
20 DAT	75.00±2.01	82.42±1.05	70.66±1.67	65.55±1.78	9.89	5.79	12.6
(B) Number of branches plant^{-1}							
5 DAT	3.82±0.77	4.50±1.20	3.23±1.76	2.53±0.90	17.80	15.45	33.77
10 DAT	6.01±1.78	6.95±2.87	5.53*±2.54	4.97±1.81	15.64	7.99	17.30
20 DAT	9.78±1.04	10.98±2.32	8.67±1.96	7.79±1.31	12.27	11.34	20.35
(C) Number of leaves plant^{-1}							
5 DAT	10.50±1.76	12.97±1.39	9.58±0.67	8.28±1.56	23.52	8.76	21.14
10 DAT	16.62±2.67	17.54*±2.78	15.44±0.99	14.01± 2.23	5.54	7.10	15.70
20 DAT	24.96±2.04	27.67±2.03	22.34±0.80	19.00±1.85	10.86	10.50	23.88
(D) Total leaf area (cm.^{2} plant^{-1})							
5 DAT	110.58±0.89	140.23±0.58	101.76*±1.43	80.48±0.48	26.81	7.98	27.22
10 DAT	280.05±1.76	330.71±1.24	220.82±1.90	196.67±1.58	18.09	21.15	29.77
20 DAT	590.60±1.23	650.29±0.91	500.25±1.45	440.81±1.05	10.11	15.30	25.36
(E) Plant biomass (gm. plant^{-1})							
5 DAT	8.34±0.56	10.60±1.77	6.26±0.81	5.49±0.89	27.10	24.94	34.17
10 DAT	27.09±0.97	30.40±2.85	24.00±1.69	19.67±1.98	12.22	11.41	27.39
20 DAT	43.00±0.69	46.09*±2.21	37.72±1.01	34.21±1.65	7.19	12.28	20.44
(F) Number of Pods plant^{-1}							
At Maturity	29.87±2.65	32.00*±3.26	27.53±4.24	22.47±3.52	7.13	7.83	24.77
(G) Number of seeds pod^{-1}							
At Maturity	9.80±1.62	12.19±2.58	8.65±2.89	6.50±1.67	24.39	11.73	33.67
(H) Dry weight of 100 seeds (gm.)							
At Maturity	3.97±0.47	4.89±0.72	3.02±0.50	2.98±0.34	23.17	23.93	24.94

± Standard Deviation

*** Value Not Significantly Different At 5% Level from Respective Control**

This might be one of the reasons for accelerated growth performance in the present study. In our study 50 ppm Chlorpyrifos treatment increased the yield attributing characters namely highest number of pods, number of seeds per plant and dry seed weight. Increased plant height, larger leaf area per plant and more up take of nutrients would have increased the translocation of photosynthates which, in turn, resulted in more number of pods per plant.

Lagana et al. (2000) observed retardation in the yield attributing character under high concentration of pesticide which is in confirmation with our result. Another reason for the decreased yield under high pesticide concentration in the soil is that it might have adversely affected the microbial activity which ultimately led to the reduction of soil fertility and productivity.

CONCLUSION

The present study demonstrates the inhibitory effect on the growth and yield of *Vigna radiata* L. at the high dose but interestingly, low dose of Chlorpyrifos supported the plant's activity and concluded that the 50 ppm of Chlorpyrifos is beneficial for the growth and yield of *Vigna radiata* L. plants.

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