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Original Research Paper

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IMPACT OF BRICK KILN EMISSION ON MORPHOLOGY AND YIELD OF MUSTARD AND WHEAT GROWING AROUND BRICK KILN INDUSTRY

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ABSTRACT The present study investigated the impact of brick kiln emission on two crop plants i.e. mustard and wheat around brick kiln industry. The morphological features and yield of both crop plants have been selected for the study. These parameters were finally compared with the same crop plants growing at control locality. The morphological features used during study include plant height and plant biomass while the yield parameters include number of seeds per plant, weight of grains per plant and weight of 100 grains. The mustard and wheat plants grown at brick kiln site showed clear cut reduction in plant height, plant biomass and all studied parameters of yield i.e. number of seeds per plant, weight of grains per plant and weight of 100 grains. The values of these parameters at brick kiln site when compared to control site are ($P<0.05$) significantly different. The study indicate the adverse impact of brick kiln emission on morphology and yield of mustard and wheat.

KEYWORDS : Brick kiln emission, mustard, wheat, yield.

INTRODUCTION

The sector which involve in the production of goods or related services are comes under industry. Industries provide rapid growth of income, employment, exploitation of resources, educational opportunities, self-sustained growth and nation's security (Bala Krishnan and Pushpangadon, 1998; Bhattachargea, 2006). Although the industries are considered back bone of economy but they causes great threat to the environment (Aivalioti and Maria,2014).

Brick kiln is one of the important small scale industry mainly present in rural and peri-urban areas (Le and Oanh, 2010). This industry is involve in the production of bricks which is one of basic construction material for making buildings. This industry require raw materials like soil or clay, fuels and cheap labour (Sarita Rupam, 2017). This industry is mainly occupied in Asian countries like China, India, Pakistan, Bangladesh, Nepal, Vietnam etc. The Asian countries produces about 1300 billion bricks annually which is 86.67% of the world's brick production (Dakhina Mitra, 2017). After China, India is the second largest brick producing country in the world. (Basu et al., 2016; Skinder et al,. 2014; Maheshwari and Jain, 2017). The number of brick kiln in India are 1,40,000 which annually produces 200 billion bricks and employed about 10 million workers. In India, this sector is unorganised and generally operates from October to June (Sarita Rupam, 2017; Maithel, 2013).

The fuel mainly used in this industry is coal. This industry also consume fuel wood, saw dust, rice husk, bagasse, used rubber, tires, plastics, waste oils etc. (D. Monte, 2017; Rob Jordon, 2017). The brick manufacturing in brick kiln causes environmental degradation (Asghar, 2002; Mazumdar et al., 2018). The pollutants from brick kilns are released through both stack emission and fugitive emission (Gao et al., 2014; Kulkarni and Rao, 2016; Narain and Roychowdhury, 2016).

The brick kiln releases large amount of dust which creates highly dusty conditions in and around the brick kiln area (Mazumdar and Debnath, 2016). During brick production, the traditional brick kiln releases number of pollutants which mainly include CO_2, CO, NO_X, SO_2 and particulate matter (Joshi and Dudani, 2008; Khalid and Masab, 2015).

The crop plants (such as wheat, mustard, cow pea, bean, gram, maize, ground nut etc.) growing near brick kiln area are adversely affected (Sadhana Chaurasia et al., 2014; Prasad and Inamdar, 1990; Chauhan and Joshi, 2010; Lerman, 1972). The pollutants released from brick kiln industry have negative impact on morphology of crop plants like plant height, plant biomass, number of leaves etc. (Nidhi Kumari, 2018; Anoop Singh et al., 2003). This is due to the negative impact on metabolic process in crop plants like transpiration rate, chlorophyll content, photosynthetic rate and metabolic respiration (Anda, 1986).

MATERIAL AND METHODS

Study Area-

The present research work was carried out in district Sultanpur of U. P. in India. It is located at 26° 30' latitude and 82° 07' longitude and is situated at elevation of 104 meter above the sea level. Total area of the district is 2672.89 km^2 and population is 3,797,117 (according to 2011 census). (District Sultanpur, Govt. of U.P.). The average temperature is 25.4°C which varies from 4.4°C to 45.8°C. The average relative humidity is 68.7% and annual rain fall is 105.4 cm. The important crops in Sultanpur are rice, wheat, maize, pea, gram, pigeon pea, sugar cane, mustard, jowar, bajra, lentil, black gram, green gram, linseed etc.

Study Site-

The present study was carried out around brick kiln area at Gosaiganj district Sultanpur, (U. P.). At brick kiln area three sites were selected which was at 100 meter, 300 meter and 500 meter distance from brick kiln area. The control locality was the campus of Rana Pratap PG College, Sultanpur (U. P.).

Plant Sampling and Analysis-

The two crop plant i.e. mustard (*Brassica juncea* Var., Varuna T-59) and wheat (*Triticum aestivum* Var.,Bapna-44) were selected for the study. The crop samples were analysed at every 30 days in case of mustard and at every 35 days in the case of wheat. The samples (in ten replicates) of mustard and wheat were collected from both brick kiln site and control site.

The plant height of mustard and wheat plants were measured with the help of scale. During the measurement of plant biomass at each sampling date, plants were dug and washed under tap water and partitioned into root, stem, leaf and floral parts. These were oven dried at 80°C for 24 hours. The yield parameters of both mustard and wheat were calculated after 120 days. Number of grains per plant, weight of grains per

plant and weight of 100 grains were determine during yield measurement.

Statistical Analysis-

To study level of significance, analysis of variance (ANOVA) using SPSS package (SPSS V 16.0, SPSS Inc., Chicago, IL) for randomized block design. Significant differences among treatments were based on the Tukey's multiple range test at $P < 0.05$.

RESULT AND DISCUSSION

Plant Height and Plant Biomass-

The values of plant height of mustard and wheat are present in Table-1. The plant height of mustard was recorded at 30, 60 and 90 days intervals. At all the intervals the height of plant increases by moving away from the brick kiln. The maximum plant height of mustard was 46.4 cm, 139.0 cm and 229.4 cm at 30, 60 and 90 days intervals respectively. In all the cases, the maximum plant height was recorded from the control locality. The minimum plant height of mustard was 39.8 cm, 87.5 cm and 153.0 cm at 30, 60 and 90 days intervals respectively. At 60 and 90 days intervals, the minimum plant height was recorded at 100m distance from brick kiln. The minimum plant height at 30 days interval was recorded from 300m. The plant height of wheat was recorded at 35, 70 and 105 days intervals. The maximum plant height of wheat was 42.5 cm, 82.4 cm and 111.5 cm at 35, 70 and 105 days intervals respectively. As in mustard, the maximum plant height of wheat was recorded from the control locality. The minimum plant height of wheat was 29.4 cm, 74.0 cm and 88.0 cm at 35, 70 and 105 days intervals respectively. The minimum plant height in all the cases was recorded from 100m distance from the brick kiln. The values of

Table1- Plant height (cm) of mustard and wheat growing around brick kiln industry and at control site

S. No.	Site	Mustard (Days)			Wheat (Days)		
		30	60	90	35	70	105
1	100 m	40.5 ±1.28^{b}	87.5±2 .39^{c}	153± 4.72^{d}	29.4± 0.83^{d}	74± 1.98^{c}	88 ±2.42^{c}
2	300 m	39.8 ±1.27^{b}	91.3 ±2.41^{c}	194.5 ±5.92^{c}	32.5 ±0.85^{c}	74.5± 1.96^{c}	102.2 ±2.97^{b}
3	500 m	41± 1.29^{b}	134 ±3.92^{b}	203.6± 6.14^{b}	36.6± 0.91^{b}	76.3 ±2.01^{b}	101 ±2.91^{b}
4	Control	46.4± 1.39^{a}	139 ±4.24^{a}	229.4 ±6.82^{a}	42.5± 1.02^{a}	82.4 ±2.17^{a}	111.5± 3.13^{a}

Values are mean of ten replicates with ± standard error (SE). Means followed by the same letter(s) within the column are not significantly different according to Tukey's multiple comparison test ($P < 0.05$).

Table2- Biomass (gm) of mustard and wheat growing around brick kiln industry and at control site

S. No.	Site	Mustard (gm)			Wheat (gm)		
		30(Days)	60(Days)	90(Days)	35(Days)	70(Days)	105(Days)
1	100 m	2.6± 0.063^{c}	14.8± 0.74^{c}	148.2± 5.12^{d}	0.36± 0.31^{c}	4.84± 0.63^{c}	2.34± 0.43^{d}
2	300 m	2.8± 0.71^{c}	15.3± 0.77^{c}	152.4± 5.67^{c}	0.40± 0.035^{c}	5.12± 0.69^{b}	2.82 ±0.51^{c}
3	500 m	3.2± 0.088^{b}	17.4± 0.86^{b}	173.5± 6.27^{b}	0.51± 0.022^{b}	5.67± 0.65^{b}	3.12 ±0.59^{b}
4	Control	3.6± 0.79^{a}	25.5± 0.91^{a}	257.3± 6.91^{a}	0.65± 0.091^{a}	7.15± 0.81^{a}	3.93± 0.61^{a}

Values are mean of ten replicates with ± standard error (SE). Means followed by the same letter(s) within the column are not significantly different according to Tukey's multiple comparison test ($P < 0.05$).

Table 3- Yield parameters of mustard and wheat growing around brick kiln Industry and at control site

S. No.	Site	Mustard (After 120 days)			Wheat (After 120 days)		
		Number of seeds per plant	Weight of grains per plant (gm)	Weight of 100 grains (gm)	Number of seeds per plant	Weight of grains per plant (gm)	Weight of 100 grains (gm)
1	100 m	3381± 10.24^{d}	20.76± 0.792^{c}	0.68± 0.018^{c}	46± 2.59^{d}	1.84± 0.1261^{d}	3.71± 0.69^{c}
2	300 m	3518± 11.19^{c}	19.66± 0.635^{d}	0.62± 0.016^{d}	48± 2.62^{c}	1.92± 0.1342^{c}	3.83 ± 0.72^{c}
3	500 m	4512± 14.36^{b}	26.92± 0.833^{b}	0.73± 0.022^{b}	55± 2.78^{b}	2.55±0.1 817^{b}	5.21 ± 0.86^{b}
4	Control	4733± 16.22^{a}	28.33± 0.862^{a}	0.75± 0.024^{a}	65± 3.13^{a}	3.92± 2.14^{a}	6.13± 0.93^{a}

Values are mean of ten replicates with ± standard error(SE). Means followed by the same letter(s) within the column are not significantly different according to Tukey's multiple comparison test ($P < 0.05$).

plant height of mustard and wheat at brick kiln site (100m, 300m and 500m distance from brick kiln) when compared to control site are ($P<0.05$) significantly different. The present study on plant height of mustard and wheat clearly suggest that brick kiln emission has negative impact on the height of plants.

The values of plant biomass of mustard and wheat are present in Table-2. The plant biomass of mustard was recorded at 30, 60 and 90 days intervals. At all the intervals, the plant biomass increases by moving away from the brick kiln. The maximum plant biomass of mustard was 3.6 gm, 25.5 gm and 257.3 gm at 30, 60 and 90 days intervals respectively. Like plant height, in all the cases, the maximum plant biomass was recorded from control locality. The minimum plant biomass of mustard was 2.6 gm, 14.8 gm and 148.2 gm at 30, 60 and 90 days intervals respectively. In all the cases the minimum plant biomass was recorded from 100m distance from the brick kiln. The plant biomass of wheat was recorded at 35, 70 and 105 days intervals. Like mustard, the plant biomass of wheat increases by moving away from the brick kiln. The maximum plant biomass of wheat was 0.65 gm, 7.15 gm and 3.93 gm at 35, 70 and 105 days intervals respectively. In all the cases, the maximum plant biomass was recorded from control locality. The minimum plant biomass of wheat was 0.36 gm, 4.84 gm and 2.34 gm at 35, 70 and 105 days respectively. In all the cases, the minimum plant biomass was recorded at 100m distance from the brick kiln. The values of plant biomass of mustard and wheat at brick kiln site (100m 300m and 500m distance from brick kiln) when compared to control site are ($P<0.05$) significantly different. The present study on plant biomass of mustard and wheat clearly suggest that brick kiln emission have negative impact on the biomass of the plant.

The reduction in plant height and plant biomass by pollutants were noticed by some workers, like Chauhan and Joshi, 2010; Khan and Khan, 1993; Mandloi and Dubey, 1988; Rao and Dubey, 1988; Katiyar and Dubey, 2000; Agrawal and Singh, 2007; Mohammad Saquib, 2008; Singh and Rao, 1986. Prasad and Inamdar, 1990; Mishra, 1982; Momen et al., 1986 suggested that the decrease in plant height and plant biomass in response to environmental pollution are due to reduced photosynthesis per unit leaf area, increased leaf senescence and increased respiration. Rao and Dekok, (1994) noticed the decrease in plant biomass of wheat due to high level of SO_2. Mckee et al.,(1997) describe the decline of wheat biomass due to O_3.

PLANT YIELD-

The values of yield parameters of mustard and wheat are present in Table-3. These parameters were recorded after 120

days after sowing. Three parameters i.e. number of seeds per plant, weight of grains per plant and weight of 100 grains were considered during study. In case of mustard, the maximum and minimum number of seeds per plant was 4333 and 3381 respectively. The maximum number of seeds per plant was recorded at control site while minimum number of seeds per plant was recorded at 100m distance from brick kiln. The maximum and minimum weight of grains per plant was 28.33 gm and 19.66 gm respectively. The maximum weight of grains per plant was recorded at control site while minimum weight of grains per plant was at 300m distance from brick kiln. The maximum and minimum weight of 100 grains was 0.75 gm and 0.62 gm respectively. The maximum weight of 100 grains was recorded at control site while minimum weight of 100 grains was recorded at 300m distance from brick kiln. In all three parameters, the maximum values were recorded from control site (i.e. away from brick kiln site). In case of wheat, the maximum and minimum seeds per plant was 65 and 46 respectively. The maximum number of seeds per plant was recorded at control site while minimum number of seeds per plant was recorded at 100m distance from brick kiln. The maximum and minimum weight of grains per plant was 3.92 gm and 1.84 gm respectively. The maximum weight of grains per plant was recorded at control site while minimum weight of grains per plant was recorded at 100m distance from brick kiln. The maximum and minimum weight of 100 grains was 6.13 gm and 3.71 gm respectively. The maximum weight of 100 grains was recorded at control site while minimum weight of 100 grains was recorded at 100m distance from brick kiln. In all three parameters, the maximum values were recorded from control site (i.e. away from brick kiln) while minimum values were recorded at 100m distance from brick kiln (i.e. near the brick kiln). In the case of both mustard and wheat, the values of yield parameters at brick kiln site (100m, 300m and 500m distance from brick kiln) when compared to control site are ($P<0.05$) significantly different. The present study on the yield parameter clearly suggest negative impact of brick kiln emission on plant productivity. Thomas (1961), and Singh and Rao (1982) observed significant decrease in yield of many cereals and pulses due to SO_2 pollution. Renaurd et al.,(1997), Heggested and Lesser (1990) and Agrawal et al., (2006) noticed the decrease in yield of many crop plants due to O_3, SO_2 and NO_2. Agrawal et al., (2003) noticed the yield reduction in wheat, mung and mustard in air pollutant areas. Krupa and Kickert (1989) suggested that the loss of crop yields is due to the decrease in photosynthetic activity and assimilate supplies which support reproductive development and growth of seeds. The similar kind of study on yield parameter of crop plants were studied by number of workers like Lee, 2000; Verma et al., 2000; Ribas and Penuelus, 2003; Pandya and Kumawat, 2020; Ashmore and Marshall, 1997; and Shakeel et al., 2019.

The present study clearly suggest the negative impact of brick kiln emission on morphological characters and yield of mustard and wheat.

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