THE EFFECT OF GASOLINE AND DIESEL FUEL MIXTURE ON SEEDLING GROWTH AND SEED GERMINATION OF RICE

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Abstract- The study was conducted to evaluate the effect of mixed gasoline and diesel fuel on seed germination and early seedling growth of rice (Oryza sativa L.). Gasoline and diesel fuel mixture treatments included 0 (control), 30, 60, and 90 ml kg^{-1} made with equal amount of gasoline oil (½) and diesel oil (½) in three replications. Plants were grown under a controlled light and temperature condition. Mixed gasoline and diesel fuel treatments showed toxic effects on seed germination and early seedling growth of rice plant. Mixture concentration of 30 ml kg^{-1} significantly reduced seedling growth parameter such as shoot fresh weight, shoot length and root length ($p<0.01$). Furthermore, increasing the concentration of mixture to 60 ml kg^{-1} showed a significant reduction in germination percentage ($p<0.01$). The results obtained in this study demonstrated that spillage of mixture of gasoline and diesel poses threats to the germination and early seedling growth of rice plant.

Key Words- Gasoline oil, diesel oil, germination, seedling growth, rice

I. INTRODUCTION

The increasing utilize of petroleum divided products such as gasoline, diesel and motor oils, has led to a marked increase in soil contamination reported in different parts of the world. Soil pollution influenced by petroleum products has reported especially in the countries such as Iran where petroleum and natural gas are obtained. Changes in soil characteristics affected by contamination with petroleum-derived materials can lead to oxygen (Atlas, 1977) and water deficits as well as shortage of available forms of phosphorus and nitrogen (Wyszkowska and Kucharski, 2000), which can be effective on soil related living organism such as plants (Aboribo, 2001; Odjegba and Sadiq, 2002). Diesel oil is one of major products of crude oil which has widely used for diesel engines of cars, industrial trucks, generators, etc. Increasing demand for diesel oil (Ogbo, 2009) has led to an increased in accidental spillage of diesel and pollution to agricultural lands through leakage from storage containers, refuelling of vehicles, wrecks of oil tankers, and through improper disposal by mechanics when cleaning diesel tankers (Hill and Moxey, 1960). Diesel oil reduces soil fertility and soil microflora population (Torstenssen et al., 1998). The soil contamination with diesel oil strongly inhibited nitrification process (Kucharski et al., 2010). Wyszokowski and Ziolkowska (2008) reported that the addition of diesel oil to the soil led to a significant reduction of organic carbon content of the soil. Anoliefo et al. (2001) reported that soil from abandoned mechanic village depressed and inhibited the growth of peanut. The findings of Ogbo (2009) and Houshmandfar, Eradatmand Asli (2011) showed a reduction in seed germination and primary root length of peanut, cowpea, sorghum, safflower and corn affected by applied different concentrations of diesel oil into the soil. This reduction depends on both level of contamination and plant species. Gasoline on the other hand is a complex mixture of organic compounds and it also has been shown to be toxic to plants (Anon, 2003; Trapp et al., 2001). Soil pollute with crude oil, automotive gasoline oil, and spent engine oil delayed the seed germination and significantly reduced germination percentage and shoot length of cowpea (Adedokun and Ataga, 2007). Although the effects of the individual petroleum products on plants have been evaluated by many studies (Anon, 2003; Andrade et al., 2004; Shahidi, 2007), limited information is available on the combined effects of different petroleum products on plant species. There is the need to study the combined effects of petroleum products on plant because most of them are present in an environment at the same time or on same environment at different times. This makes it difficult to point to one particular petroleum divided product as the cause of a specific effect on plants (Njoku et al., 2009). Hence, the objective of this study was to evaluate the effect of mixed gasoline and diesel fuel at different levels on rice in early growth stage.

II. MATERIALS AND METHODS

The experiment was laid out in completely randomized design (CRD) with four gasoline and diesel fuel mixture treatments in three replications. Mixed gasoline and diesel oil treatments included 0 (control), 30, 60, and 90 ml kg^{-1} made with equal amount of gasoline oil (½), and diesel oil (½). The soil was mixed thoroughly with the mixture using a glass rod. General-purpose plastic pots were filled with four kg of the treated soil which classified as a clay loam with 27.9% Sand, 26.2% Clay and 45.9% Silt, with an electrical conductivity (EC_e) of 1.4 dS m^{-1}, and a pH of 7.4 (saturated paste). Five seeds of rice plant (Oryza sativa L.) washed with deionized water

and put into each pot. The plants were grown in a green house at 26/18°C (±2) day/night temperature and a photoperiod of 12 h at approximately 1500 luxes. At the planting time, 25 ml of a modified Hoagland's nutrient solution containing macro and micro elements were applied to each pot (Peralta et al. 2001). The pots were watered with deionized water as described by Houshmandfar and Tehrani (2008).

Plants were collected at 24th day after sowing (DAS), evaluated for root and shoot length and fresh biomass, washed with water and deionized water, oven dried at 70°C for 72 h, weighed for determined biomass accumulation including root and shoot dry biomass. Root length was measured from the main apex to the crown, whereas shoot length was measured from the crown to the main apex. Germination percentage, the vigor index (VI), and tolerance indices (TI) (Iqbal and Rahmati, 1992) were determined by the following formula:

$$\text{Germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Total number of planted seeds}} \times 100$$

$$\text{VI} = \text{Seedling length (cm)} \times \text{Germination percentage}$$

$$\text{Tolerance indices} = \frac{\text{Mean root length of polluted area seeds}}{\text{Mean root length of control area seeds}} \times 100$$

Data for various growth indices were subjected to analysis of variance using SAS/STAT software version 8 (SAS Inst. 1999). Duncan's multiple range test (DMRT) (Dancan, 1955) at the 0.05 level of probability was used to evaluate the difference among treatment means.

III. RESULTS

Table 1 indicates the effects of gasoline and diesel fuel mixture treatments on germination percentage and various early seedling growth characteristics of rice. Mixed gasoline and diesel fuel treatments inhibited seed germination significantly at 0.01 level of probability. Seeds germinated best in the non mixture control. The number of germinated seeds was markedly suppressed at higher mixture level of 90 ml kg^{-1}. Variation in the set of accessions was not possible to discern at mixture level of 40 ml kg^{-1} along with control treatment. However, accessions differed significantly at the higher mixture levels of 600 and 90 ml kg^{-1}. The mixture concentrations of 60 and 90 ml kg^{-1} inhibited seed germination with 8.90% and 21.21%, respectively. Shoot fresh weight was inversely correlated to the mixture concentrations added to the soil. Mixed gasoline and diesel fuel doses of 30, 60 and 90 ml kg^{-1} inhibited shoot fresh weight with a reduction of 11.18%, 43.21% and 56.11%, respectively ($p<0.01$). The root fresh weight was diversely influenced by different mixture treatments. However, application of 90 ml kg^{-1} of mixture produced the minimum amount of root fresh weight with a reduction of 60.12% as compare with control treatment ($p<0.05$). Shoot and root dry weight showed opposite response due to the mixture stress. Shoot dry weight presented a negative response to the mixture concentrations added to the soil ($p<0.01$). However, root dry weight was positively affected by the mixture treatments. The root dry weight was significantly increased at 30, 60 and 90 ml kg^{-1} concentrations of mixed gasoline and diesel fuel as compared to control treatment ($p<0.05$). However, variation in the set of accessions was not possible to discern at mixture levels of 30, 60 and 90 ml kg^{-1}. A negative response of shoot and root length of rice to gasoline and diesel fuel mixture application relative to the non mixture control treatment was observed in all levels ($p<0.01$). Mixed gasoline and diesel fuel concentrations of 30, 60 and 90 ml kg^{-1} inhibited shoot elongation with a reduction of 12.31%, 24.23% and 26.97%, and reduced root length with a decrease of 23.01%, 24.12% and 30.53%, respectively.

Table 1. Overall mean values for various traits of rice germination and seedling growth under different concentrations of gasoline and diesel fuel mixture.

Concentration (ml kg^{-1})	Germination (%)	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Shoot length (cm)	Root length (cm)
0	84.35^{a} ± 2.23	4.94^{a} ± 0.29	0.34^{b} ± 0.03	0.29^{a} ± 0.02	0.06^{b} ± 0.01	10.90^{a} ± 0.60	11.22^{a} ± 0.09
30	86.61^{a} ± 2.19	4.45^{b} ± 0.34	0.42^{a} ± 0.04	0.24^{b} ± 0.03	0.11^{a} ± 0.03	09.98^{b} ± 0.21	09.11^{b} ± 0.24
60	79.82^{b} ± 4.96	3.13^{c} ± 0.39	0.36^{b} ± 0.03	0.20^{c} ± 0.01	0.10^{a} ± 0.02	09.21^{c} ± 0.20	08.12^{bc} ± 0.19
90	66.34^{c} ± 2.18	2.45^{d} ± 0.31	0.18^{c} ± 0.02	0.22^{bc} ± 0.02	0.09^{a} ± 0.00	08.43^{c} ± 0.18	08.01^{c} ± 0.30

Note: Within a column, means followed by the same letter are not significantly different at the 0.05 level of probability by Duncan's multiple range test; SE (±), standard error.

Figure 1 indicates the effect of gasoline and diesel fuel mixture on vigor index and tolerance indices of rice. Mixed gasoline and diesel fuel concentration of 30, 60 and 90 ml kg^{-1} decreased the vigor index with a reduction of 16.90%, 27.91% and 67.92%, as compare with control treatment, respectively. The tolerance indices showed a decrease of 3.12% and 11.10% at mixture doses of 60 and 90 ml kg^{-1}, as

compare with mixture concentration of 30 ml kg^{-1}, respectively.

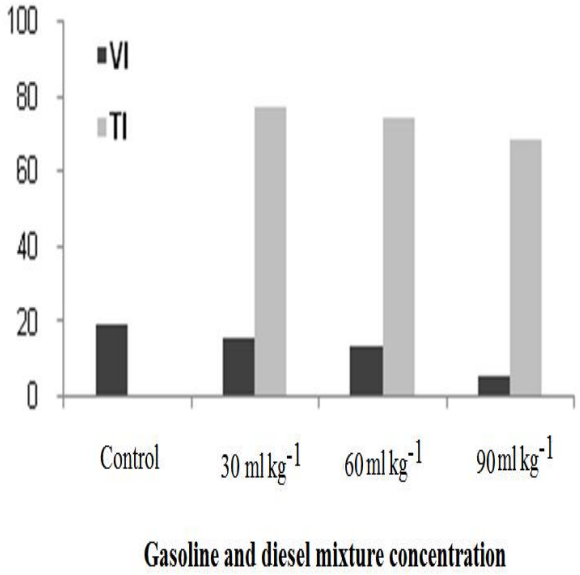


Figure 1. Vigor index (VI) and tolerance indices (TI) of rice exposed to different gasoline and diesel fuel mixture concentration.

IV. DISCUSSION

This research showed that how gasoline and diesel fuel mixture treatments effected germination and early growth stage of rice plant. Mixed gasoline and diesel fuel treatments decreased seed germination and most of the seedling growth parameters such as seedling fresh weight and seedling elongation of rice. Reduction in seed germination and seedling growth provided evidence that the petroleum products such as gasoline oil and diesel oil if present in the soil-plant environment are responsible in producing toxic effects which reduced plant development. The decrease in seed germination and seedling growth due to petroleum-derived substances is in conformity with the findings of other researchers (Sun et al., 2004; Akaninwor et al., 2007). Njoku et al. (2009) observed a reduction in germination percentage, shoot length and root length of cowpea treated with gasoline and diesel fuel mixture. Treatment of amaranth plant with spent oil showing a gradual reduction in shoot length (Odjegba and Sadiq, 2002). Njoku et al. (2008) also found similar findings on the effect of crude oil to growth of accessions of soybean and tomato. Furthermore, Adedokun and Ataga (2007) reported that treatment of soils with crude oil, automotive gasoline oil and spent engine oil significantly affected the time of germination, germination percentage, plant height, and leaf production of cowpea. The toxic effect on germination percentage and seedling growth in this present study could be viewed as a function of lower water and nutrient uptake related to water and nutrient bioavailability. The degrading effect of petroleum-derived compounds on soil leads to severe nitrogen and phosphorus depletion, reduction of water balance and biological equilibrium (Baran et al., 2002). Dimitrow and Markow (2000) showed that the presence of oil in the soil significantly decreased the available forms of phosphorus and potassium to plants. Nutrients such as nitrogen, phosphorus, potassium and oxygen along with water are essential to plant growth and development. Hence, reduction in their bioavailability will lead reduced plant growth. General observation in this study can concluded that gasoline and diesel fuel mixture like the other petroleum divided product produced toxic impact on germination and seedling growth of plant. Increase in the concentrations of the mixture into the soil, brought up changes in germination percentage and all of the determined early seedling growth parameters. The identification of the toxic concentration of individual and mixed petroleum products on different plant species would be helpful for the establishment of an environment quality standard. The findings can also contribute to better physiological fragility, the potential of rice in coordinating in crop management programmes in petroleum divided products contaminated areas.

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