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Negative Influence of Johnson Grass (*Sorghum halepense* L) on Yield of Crops Along with the Strategies to Suppress its Growth with Chemical and Other Management Approaches – A Review

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Authors' contributions

This work was carried out in collaboration between all authors. Author NMK designed the idea, study the literature and collected online data and wrote the first draft of the manuscript. Authors GM and AA managed and proofread the finals draft. Author MABK managed the literature searches and collaborated in designing the idea. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Johnson grass is on the most deleterious, tenacious, threatening and pervasive weed and is found almost in complete globe except Antarctica. It is ranked in top ten worst weeds of all time. The main regions of its growth and spread are USA and Europe. The average height of Johnson grass lies between 3ft-10ft which is enough for survival and causing destruction to plants of main crop. It is

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narrow leafed weed belonging to family of sorghum which belong to Poaceae family. It has deep rooted system containing thick and fleshy rhizomes which are the main reason for its spread. These rhizomes have the ability to extend up to 80m. In this present review, information is gathered about the ecology and biology of Johnson grass along with its economic impact on crops and its control measures through different chemicals and management practices. The main focus of review was on growth mechanism and most importantly on its control of Johnson grass. From this whole discussion we have concluded that use of chemical herbicides is most effective in controlling its spread. Application of glyphosate and asulam as chemicals proved to be best in performance and in management practices or non-chemical methods black plastic sheet and soil solarization are well adopted conducts to suppress its growth to large extent. Along with that combination of chemicals and non-chemical practices would be recommended as they not only diminishes the growth of Johnson grass but also enhances the crop productivity.

Keywords: Johnson grass; crop yield; soil health; chemical herbicides; management practices.

1. INTRODUCTION

Sorghum halepense is locally known as Johnson grass, baru grass and barul grass in different regions of world [1]. It is widespread and trouble causing native weed present in all over the world and mostly present in Europe, USA, some countries of Africa, Middle East and in south Asian countries like Pakistan and India [1]. In more than 53 countries it is categorized as serious weed. It thrives in all crops especially in maize, sorghum, soybean and sunflower etc. [1]. It is produced by the cross of *Sorghum arundinaceum* and *Sorghum propinquum* by doubling of the chromosomes [2] Johnson grass can grow and survive in diverse environment from dry land areas to highly humid areas, from edges of canals to the barren lands [3] Under drought stress conditions Johnson grass can thrives more aggressively and can damage main crop to large extent [4] Allelopathic chemicals that Johnson grass releases especially from roots exudates have put great strain on crops like maize and cotton etc. [5]. From research it is found that putting the leaves of Johnson grass on the seedlings of wheat put pressure on its growth and fresh weight is diminished [6]. Johnson grass is tough weed that has very high reproductive ability and its rhizomes can extend up to 70m in one growing season which can produce about 28,000 seeds from single plant [7]. Johnson grass is more viable and active in growth during high temperature usually in summer season and its seedlings and rhizomes have ability to cope against harsh environments [8]. Johnson grass has capability to cope harsh conditions which can make its survival best. During cold weather its rhizomes become dormant and can endure this condition which make it noxious weed [9]. The roots and rhizomes of Johnson grass has high penetrating power than any other plant which will provide high and wide range of growing grounds even its performance of growth and development is aggressive in drought conditions [4]. Increased population of Johnson grass is well adapted in rainfed areas and this high population is invasive to crops in this eco-region. Change occurrence in climate has increased the temperature of this region which effect the whole cropping pattern but the population of Johnson grass has performed even better in this changed climatic conditions [10]. The plant height and sprouting of Johnson grass is enhanced when its roots reached to the depth of 6 inches but how much time it takes to sprout is independent of soil depth and level of moisture available to plant [11]. Johnson grass was firstly introduced in some native areas of USA in 1800s as a fodder purpose but by the end of 19th century it is grown in most parts of USA Johnson is reproduced and propagated through its seed and rhizome dispersal that remain dominant in soil for several years and tillage implements wok as transporter of seeds. Stems and aerial portion are also involved in its reproduction. The average height of Johnson grass ranges from 3ft to 10ft.Rhizomes has ability to grow the depth of 10-20 inches depending upon the soil condition [12]. Johnson grass has extensive and complex root system and have dense and thick rhizome population present in soil and these rhizomes have ability to regenerate themselves in all kind of environmental facets. The best temperature for the healthy emergence of Johnson grass is about 10C with proper availability of light and then it can survive up to 30 to 40C without any interruption. It cannot tolerate high temperature and exposure to temperature from 50-60C can kill the whole plant including its rhizomes [13]. The echelons of sucrose, glucose and fructose present in rhizomes are roughly equally in temporal form but when it is observed individually

there is bit difference in their echelons [14]. Johnson grass having growth period of 4 weeks has put great pressure on the cotton yield. About 70% plants of Johnson grass are present in 9.8m of row [15].

2. EFFECT OF JOHNSON GRASS ON YIELD OF CROPS

40-76% losses are observed in cotton field by invasion of Johnson grass. Ginning losses are also under account by its invasion [16]. Heavy competition of soybean and Johnson grass leads to higher yield losses of soybean ranging from 59-88% [17]. Johnson grass roots great losses to annual production and put great impact on country's economy. The loss of annual yield caused by incursion of Johnson grass points varies from 13% to 54% depending on the region [18]. This weed belongs to Poaceae family and this family contributes about 51.4% of total weed species present in Bannu district but from this Johnson grass has subsidizes in different levels depending upon the crop. It is found copious in sugarcane, maize and rice [19]**.** The average height of each plant of Johnson grass is up to 8m which suppresses the growth of cotton and decreases its yield from 7 to 30% depending upon the plants present in each row of cotton [20]. The invasion of Johnson grass exceeded from 150 plants/ m^2 will results in 100% yield loss and Johnson grass tripled its population due to absence of control measures from previous year [21]. It is estimated that there would be great loss of yield in field of maize and oil pumpkin due to Johnson grass. Approximately 41% of grain maize and 40% of oil pumpkin have risk of yield loss [22]. Combine use of herbicides and soil tillage help in suppressing the emergence of rhizomes for long and short term [23]. Incursion of Johnson grass in field of sunflower leads to yield losses between 30-70% from 80% of total losses [24].

3. SUPPRESSION OF JOHNSON GRASS BY USE OF CHEMICAL HERBICIDES

By the use of nicosulfuron at the rate of 48 to 60g a.i. /ha in the soil with proper hoeing in proper time help in controlling the growth of Johnson grass to large extent. Proper management is necessary as it is having very dense rhizomes that once penetrated deep in the soil it would be difficult to control [25]. There are enormous numbers of herbicides that are used to suppress the population of Johnson grass in soybean field but quizalofop, fluazifop and glyphosate have proven to be best in performance which can control population of Johnson grass from 80 to 95% [26]. Low availability of N in the root leachate amends soil results in the greater reduction of biomass of plant as compared to shoot leachate amend soil especially root dry weight and due to this low availability of N increases the interference potential of Johnson grass [7]. Controlling of weeds in soybean field from *Sorghum halepense* Water Extract (SHWE) has been proved best as it optimizes the yield up to 42.51% when SHWE is sprayed three times in field without causing any damage to environment [27]. Selection of herbicides is very much important especially for Johnson grass whose height reaches to 30 cm and single application of glyphosate or clethodim not only decreases the soil seed bank of Johnson grass but also reduces its success of progeny in upcoming years [28]. The infestation of Johnson grass is high at the edges of maize field as compared to the middle and the field that is irrigated by sprinklers has high rate of invasion near the sprinkler lines. Development of spraying system that needs to be more reliable, spatially precise and practical detected and fully mapped [29]. Cochliobolus intermedius is fungi present on the diseased crabgrass (Digitaria sp.) which was extracted and sprayed on the weeds including Johnson grass has exhibited mortality and there is also reduction in dry matter of the weed species present in field [30]. Extract of different fungus pathogens are sprayed and have provided resistance against seven different grasses including Johnson grass which further enhances the use of bio herbicides [31]. Combine spray of asulam and trifloxysulfiron impedes the spread of rhizomes of Johnson grass and also maximizes the yield of crop [32]. Allelopathic extract of lavender and basil have strong negative effect on pigweed and twitch but spearmint has shown significant and prominent inhibitory effect even in small quantity on all the weeds including Johnson grass while wheat remains unpretentious from these allelopathic excerpt of lavender, basil and spearmint [33]. Growth of Johnson grass is suppressed by combine application of post emergent herbicides including metribuzin at 0.3 l/ha + S-metolachlor at 1.2 l/ha with an efficiency of 92-94% including seeds and rhizomes [34]. Pendimethalin shadowed by sulphosulphuron is applied in the wheat-mungbean cropping system which decreases the dry matter of weeds in wheat and their effects are sustained by mungbean in next season. Use of zero tillage with combination of herbicide have better control of weed [35].

4. SUPPRESSION OF JOHNSON GRASS THROUGH DIFFERENT MANAGEMENT PRACTICES

Ultrasonic sensor is technique used to detect the presence of different weeds including Johnson grass by mounting this ultrasonic sensor in front of tractor which then senses the presence of weeds and grasses and this technique gives new development of selective weed control method [36]. Sowing of main crop before the season will lower the competition with Johnson grass especially in maize and cotton fields. Ploughing the soil immediately after harvest of previous crop and then precise tillage is used to cut down the rhizomes and also weakens the standing plants of Johnson grass [37]. Rotation of different crops along with other practices like deep ploughing with moldboard plough and furrow irrigation in fields especially in field of maize help in depressing the growth of Johnson grass [38]. Solarization is effective in controlling of Johnson grass in field which is covered from 40-50% of its population. This solarization has also increase significantly the level of NH4-N and NO3-N in the soil when plastic is placed on it [39]. Combination of sorghum mulch and sorghum extract water has provided efficient weed control and also optimized the yield of grains [40]. Growing and mulching of *sorghum bicolar* provide excellent way to control all the weeds including Johnson grass. Roots and upper parts of sorghum contain allelopathic chemicals i.e., sargoleone and phenolic compounds respectively which cope against harmful weeds [41]. Ground cover system (GCS) not only controls the infestation and growth of emerged weeds in field but also involved in soil fortification and water preservation. The GCS includes different type of mulches including plastic sheet, straw mulch, paper mulch, carpet mulch etc. [42]. Application of black polythene sheet as a mulch in field is very much effective in controlling weeds whose efficacy is about 95.15% followed by white polythene sheet which has efficiency of 83.1% [43]. Use of laser on the apical meristem has caused suppression in the growth of different weeds present in the field and its efficacy depends upon the wavelength, spot size and laser point [14]. Variation of different weed managing practices is dreadfully nominal in controlling weeds population and also decrease their resistance against herbicides [44]. Weed biomass is decreased from 41-60% with the increase of seed rate from 20 to 100kg/ha which suggests that increase in seeding rate results in higher productivity of crop and suppress the population of weeds present in field [45]. Optimization of seed rate from normal rate have increased the yield of rice by overwhelming the infestation of weeds and this high seed rate declines the use of herbicides which are responsible to environmental issues [46] Using of tillage practices with combination of increased seed rate and hand weeding depresses the germination and biomass of weeds [47]. Enhancing the crop competition among the weeds is proven to be effective in controlling weeds emergence in field. This competition can be enhanced by taking in account the competitive species, increase of seed rate, narrow spacing and altered row orientation [48]. Soil solarization before sowing of the main crop is effective and efficient practice to reduce the germination rate of many weeds including Johnson grass [49]. Solarization along with use of polythene sheet has reduced the weed emergence and reduced its critical period [5]. Rice mulch in field of mungbean is proven to be good in optimizing the yield of mungbean especially where roots are unable to penetrate in soil [50].

5. CONCLUSION

The key aim of this review was to establish control measures for this hard, persistent and dangerous weed that gives farmers and researchers tough time. From this review we have concluded that managing and suppressing Johnson grass is long term procedure that would be expensive for farmers and would require high and proper maintenance and treatment. Johnson grass biology shows that it is a long plant that shadows the main crop and its rhizomes are deeply rooted and can flourish in nearly all soils with little water supply. The use of herbicides is a management technique that is primarily used for its destruction. Glyphosate has been used to manage it at varying quantities and rates depending on the crop and soil. Solarization of the soil and deep ploughing of the soil have proven to be better managed because it cannot withstand high temperatures. The choice of management practice depends on the area where it began to develop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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