1.INTRODUCTION

Barley is one of the most ancient crops cultivated already since 10 000 years ago. Barley cultivated for food and feed belongs to the species *Hordeum vulgare L*. **(Harlan, 1995).** Barley is the fourth most important cereal crop after wheat, rice, and maize. It is used for human consumption and animal feeding. Barley production in Egypt is located in north coastal region and newly reclaimed land **(FAO, 2015).**

Barley is used for various purposes throughout the world. The majority produced barley in the world is used as feed for animal consumption. Large amounts of barley grains are also used for malting processes (for making beer and other types of alcoholic beverages). In addition, barley is used for various food products, for human consumption e.g. soups, cereals, baked goods and baby food (**Poehlman, 1994**). It is also an important food crop in northern Africa , where the soils and environmental conditions are not suitable for production of other grain crops (**Poehlman, 1985**). In recent years, the development of hulless barley has increased.

In Egypt , barley is annually grown in nearly 190.000 feddans (fed = 4200 m^2) . Out of these , 70,000 fed are grown in irrigated lands in addition to more than 120.000 fed are watered by rain along the north coast (**Anonymous ,2015)**

An alternative control approach against net blotch would be based on economically technically feasible and environmentally safe strategy

Two rowed barley (*Hordeum distichum*) are the best barley for brewing, science the grains are better developed. The husks which are also thinner give less extract containing undesirable material which would impair the quality of the beverage industry product. Two rowed barley are known as spring barley, because in Europe they are generally sown at the end of winter and beginning of spring.

Six rowed barley (*Hordeum hexastichum*) are known as winter barely, because they are sown in the autumn. Science the ear carries six rowed of grains, the individual grains are not so well developed as in two rowed cultivars and the husk is thicker. For these two reasons, six rowed cultivars give less extract and are mainly cultivated as feed for stock. Two-row barley has lower protein content than six-row barley, thus more fermentable sugar content. High protein barley is best suited for animal feed. Malting barley is usually lower protein (**Johnston *et al*., 2009)** .

Barley is preferred not only for its nutritional importance but also for its nutraceuticals properties. The active component in barley having nutraceutical property the soluble fiber (1-3) (1-4)- β-D-Glucan or β-Glucan. β –glucan which is Polysaccharides found principally in the cell walls of the aleurone layer and endosperm . in barley kernels.The effect of beta glucans in the cardiovascular disease prevention is already known(**Bhatty, 2011**). In barley they are more concentrated in the endosperm (**Bhatty, 1993**).

Under warm and humid conditions expression of barley net blotch (BNB) caused by *Pyrenphora teres* Ana morph : *Drechslera teres,* (**Tekauz, 2003**) . Disease symptoms can increase rapidly , causing substantial grain yield loss 27% on an average and up to 34% when it is severe (**Yitborek and Wudneh .1985) .**

Several control methods against *P. teres* had been recommended, such as crop rotation, the application of fungicides and the use of resistant cultivars . The use of genetic resistance is the favoured for controlling this disease , however ; it is complicated by the existence of several pathotypes of the pathogen (**Wu and Steffenson**, **2003**) and (**Boungab *et al*. ,2012**).

Many investigations have been made for understanding the physiological and biochemical basis of induce systemic resistance (ISR). Much of this knowledge is due to the identification of a number of chemical and biological elicitors , some of them are commercially available for use in conventional agriculture **(Gary and Robert , 2004 ; Gomez and Stuefer , 2006).** Several natural and synthetic chemical agents have been described as activators of defense related processes when applied to plants. Some of these activators may have potential application in agriculture **(Yamaguchi, 1998)**

This systemic induction is thought the heightened defensive capacity of the systemic tissues in ISR. At the cellular level these defence reactions are preceded by numerous changes including the synthesis of salicylic acid reactive oxygen species (ROS) ,nitric oxide (NO) and the hypersensitive reaction **(Veronese *et al*., 2003) .**

Application of humic acids (HA) has several benefits and agriculturists all over the world are accepting humic acids as an integral part of their fertilizer program . It can be applied directly to the plant foliage in liquid form or the soil in the form of granules alone or as fertilizer mix . Humic acid is one of major component of humus . Humates are natural organic substances , high in humic acid and containing most of known trace minerals necessary to the development of plant life . Humic substances are an important soil component because they constitute a stable fraction of carbon and improve water holding capacity, pH buffering and thermal insulation(**McDonnell *et al.,* 2001**). Studies of the positive effect of humic substance on plant growth have demonstrated the importance of optimum mineral supply independent of nutrition (**Yildirim , 2007**).

Nanotechnology can be used for combating the plant disease either by controlled delivery of functional molecules or as diagnostic

tool for disease detection. Nanotechnology, nano particles and quantum dots (QD) have emerged as pivol tool for detection of a particular biological marker with extreme accuracy (**Madhuri Sharon *et al.*, 2010**). Chitin and chitosan are naturally occurring compound that have potential in agriculture with regard to controlling plant diseases. These molecules were shown to display toxicity and inhibit fungal growth and development. Fragments from chitin and chitosan are known to have eliciting activities leading to a variety of defense responses in host plants in response to microbial infections, including the accumulation of phytoalexins , pathogen- related (PR) proteins and proteinase inhibitors , lignin synthesis and callose formation .Based on these and other proprieties that help strengthen host plant defenses, interest has been growing in using them in agricultural system to reduce the negative impact of diseases on yield and quality of crops .(**El Hadrami *et al*.,2010**)

The objectives of the present work were proposed to investigate the effect of some safe resistance inducers for controlling the barley net blotch disease under greenhouse and field conditions to improve it's technological quality through the following points :

- The effect of fungicide in different growth stages against net blotch of barley adult plant stages using two rowed hulled(Giza 127& Giza 128)and six rowed hulls (Giza 129 & Giza , 130) .
- Determine the disease severity and each of one thousand kernel weight (TKW) , plot weight , total protein , total lipids , total fiber , crude ash and total carbohydrates .
- The effect of using different chemicals as resistance inducers against net blotch of barley under green house and open field conditions .

- Determination of enzyme activities: Peroxidase activity , Polyphenoloxidase activity , β – 1,3 glucanase and phenolic compounds .
- Determine the biological effect of the barley cultivar on blood lipid profile in tested animals Determine the technological properties of barley cultivar for crepes production .

2.REVIEW OF LITERATURE

2.1.Barley Grain

Barley is an ancient domesticated grain. The earliest archaeological evidence for barley cultivation is in the fertile crescent region of the middle east in approximately 8000 BC **(Newman and Newman, 2006)and (Baik and Ullrich, 2008).** Barley is the fifth among all crops in world production (annual 129-million-metric-ton averages in 2002–2005, behind corn, wheat, rice, and soybeans) **(Baik and Ullrich, 2008).** Currently, about two-thirds of the world's barley harvest is used for animal feed, one-third for malting and only about 2% for human food **(Baik and Ullrich, 2008).** Although most barley cultivars are traditional "hulled" cultivars, researchers have developed numerous "hull-less" (also called hull-less or naked) cultivars. Like hulled barleys, these hull-less cultivars have hulls in the field, but the hulls fall off during growth and harvest, resulting in a grain that has lower fiber and does not need to be pearled before being used in food applications **(Ames *et al*., 2006).**

Hulled barley grain is first de-hulled and then further pearled, polished, flaked or ground to grits or flour before being consumed, prepared into food products or used as an ingredient. De-hulling, pearling and polishing of barley grains are accomplished by abrasion, which subjects the grains to a rotating abrasive surface. Dehulling mainly removes the hull and also small portions of the bran, germ and endosperm. Pearling the de-hulled or genetically hulless barley grains further removes the remaining hull, bran, germ and also part of the endosperm. Pearled grains may be steam-cooked and sliced to produce barley flakes (**Baik and Ullrich, 2008).**

Pearled barley grain may be cut along the crease and polished to produce ‘‘cut barley’’ which is mainly consumed with rice as an

extender. Cutting barley grain along the crease and subsequent polishing makes it resemble polished rice grain in visual appearance and size, and also speeds up water imbibitions, consequently reducing the cooking time. This makes the use of barley as a rice substitute more attractive, and increases consumer acceptance **(Baik and Ullrich, 2008).**

Barley flour is commonly prepared by hammer milling pearled grain. The non-uniform removal of the bran during pearling and the remaining crease part of the grain make it difficult to produce clean, white barley flour. (**Bhatty, 1986a, b)** explored the production of barley flour by roller milling, milling hulless barley to obtain about 74% flour yield using a Buhler mill with adjustments to the milling conditions.

Whole barley grain is mostly used for feeding animals. For food purposes barley is mainly used as de-hulled grain or high fiber content products. Food produced from barley is a good source for many nutrients such as protein, fiber, minerals and B-vitamins.

2.1.1.Chemical composition of barley

Whole barley grain consists of about 65–68% starch, 10–17% protein, 4–9% β-glucan, 2–3% free lipids and 1.5–2.5% minerals **(Izydorczyk *et al.*, 2000 and Quinde *et al.*, 2004).** Total dietary fiber ranges from 11 to 34% and soluble dietary fiber from 3 to 20% **(Fastnaught, 2001).** Hulless or de-hulled barley grain contains 11–20% total dietary fiber, 11–14% insoluble dietary fiber and 3–10% soluble dietary fiber **(Fastnaught, 2001 and Virkki *et al.* 2004).** Pearling reduces the contents of insoluble fibre, protein, ash and free lipids, but increases the contents of starch and β-glucan by the removal of outer layers, including the hull (palea and lemma), bran (pericarp, testa) and germ (embryo), which are richer in insoluble fiber, protein, ash and

lipids and poorer in starch and β-glucan than the endosperm **(Quinde *et al.*, 2004 and Quinde-Axtell *et al.*, 2006).**

Three major constituents are accumulated in barley during grain filling: starch, lipids, and proteins. Starch constitutes ≈61% of the mature grain dry weight in barley **(MacGregor and Fincher, 1993).** Cereals contain different kinds of lipids: membrane-bound oil droplets in the aleurone layer, scutellum and embryo, and lipids found in the endosperm **(Morrison, 1978).** Lipids constitute 1–3% of the cereal grain depending on genetic constitution **(Jacobsen *et al.*, 2005).** The lipids in the endosperm are lysophospholipids complexed with amylose **(Morrison, 1993).**

In barley, proteins account for 8–13% dry weight, the majority being storage proteins surrounding the starch. The protein content and composition are also genetically dependent and mutants in an isogenic background; for example, the *lys3a* mutant has an extreme reduction in alcohol soluble proteins and hordeins compared with the parental line **(Jacobsen *et al.*, 2005).**

Barley contains β-glucan as a source of soluble dietary fiber. The barley flour was prepared from Pakistani barley cultivar (Haider-93) and analyzed for its chemical composition. The barley flour possessed 11.48% total dietary fiber and 4.87% β-glucan content. β-glucan extracted from barley flour contained 75.05% soluble dietary fiber 10.25%, insoluble dietary fiber and 85.30% total dietary fiber. The beverage was prepared by incorporating β-glucan at 0, 0.2, 0.4, 0.6, 0.8 and 1.0% levels **(Din *et al.*, 2009).**

2.1.2.β-glucan and total fibers content

Mixed linked (1-3), (1-4) β-D-glucans constitute approximately 75% of the barley endosperm cell walls together with 20% arabinoxylans and protein **(Henry, 1987).** The β-glucans in the

endosperm cell walls may be covalently bonded to protein, forming large molecules of 107 Da **(MacDougall and Selvendran, 2001).** Both β-glucans and arabinoxylans determine wort viscosity and beer filtration rates **(Stewart *et al.,* 1998 and 2000)**, and form a barrier for hydrolytic enzymes attacking starch and protein within the cell walls. Accordingly, low β-glucan content of grain and/or its breakdown during malting are critical issues in brewing. On the other hand, reported the importance of a minimal amount of β-glucans on foam stability of beer. Barley grain usually contains 2–10% β-glucan **(Henry, 1987).** However, a b-glucan rich hulless waxy barley isoline 'Prowashonupana''(high protein, waxy, short awn nude 'Compana') contains 15–18% β-glucan **(Andersson *et al.,* 1999).** Because the waxy starch phenotype is usually associated with high β-glucan content, waxy endosperm types generally have greater β-glucan contents than barley types with normal starch **(Newman and Newman, 1991). Izydorczyk *et al.,* (2005**)observed significant differences in β-glucan content among barley types with various starch amylose contents.nThe average β-glucan content was 7.5% in high amylose, 6.9% in waxy, 6.3% in zero amylose waxy and 4.4% in normal starch types. **Munck *et al.,* (2004)** showed that the lower starch content of the high lysine barley mutants Riso 13 and 29 carrying the lys5 allele was offset by increased β-glucan content. These mutants had a normal amylose level and 15–20% β-glucan. (**Pe´ rez-Vendrell *et al.,* 1996)** found higher β-glucan content in winter vs. spring types. The β-glucan content of barley grains is mainly determined by genetic factors **(Powell *et al.,* 1985)** and less by environmental factors during the grain filling period **(Henry, 1986 and Stuart *et al.,* 1988). Pe´ rez-Vendrell *et al.,* (1996), Fastnaught *et al.,* (1996) and Yalcin *et al.,* (2007)** also noted significant influences of both genotype and location on β-glucan content of barley grain. Waxy

hulless cultivars generally exhibited much greater grain β-glucan contents than normal covered cultivars, while there were no differences in the β-glucan contents of two-row and six-row cultivars **(Fastnaught *et al.*, 1996). Greenberg (1977)** estimated that β-glucan content is controlled by two to three dominant genes. Analysis of the Steptoe/Morex mapping population revealed three QTLs, one on chromosome 1H and two on chromosome 2H, each explaining 5–20% of the variation **(Han *et al.*, 1995).**

The fiber content of barley is high and rich in β-glucan that is mainly soluble. Fiber rich cereals such as barley are beneficial for balancing the human diet in a manner that is of no relevance for animals. Low-digestible carbohydrates, especially β-glucan and resistant starch have a positive impact on lowering post-prandial blood glucose levels. Further, β-glucan has been reported to reduce the blood cholesterol level. Barley products are thought to be good for diabetics, obese and overweight people and for those who have a high blood cholesterol level **(Kahlon and Chow, 1997).** The β-glucan from barley is also known to stabilize digestion processes in young farm animals, especially in piglets **(Bolduan and Jung, 1985).** However, due to its viscosity enhancing property, β-glucan causes undesirable effects in the digestive tract especially of young avians. But with increasing age of the birds the antinutritive effect decreases **(Jeroch *et al*., 1993).**

2.1.3.Protein content

The proteins of barley can be divided into four solubility groups: albumins (water-soluble); globulins (soluble in dilute saline); prolamins (soluble in alcohol / water mixtures); and glutelins (soluble only in dilute acid or alkali). Prolamins, called hordeins in barley, are the major storage proteins and account for 35 to 50% of the total nitrogen in the

grain. The albumins, globulins, glutelins consist predominantly of structural and metabolic proteins **(Kreis and Shewry, 1992).**

The protein content of barley grains varies considerably. The precise composition depends on the growth conditions and on the rate and timing of nitrogen fertilisation **(Duffus and Cochrane, 1993).** For this reason it is important that an appropriate comparator is used for the comparative analysis. Barley endosperm protein is rich in prolamin storage proteins (hordeins) and has moderate nutritional quality with protein efficiency ratio averaging 2.04 (**Newman and McGuire, 1985**). High lysine barley mutants, which contain 2–3% greater lysine than normal lysine types (w5–6% vs.w3%) (**Ullrich and Eslick, 1978a**) could provide high quality protein enriched in lysine for developing countries (**Newman and Newman, 1991**). These mutants may also contain up to 20% protein **(Newman and Newman, 1991).** Extensive studies and breeding have been carried out to improve the nutritional quality, notably the lysine content of barley protein, primarily in the 1970s and 1980s **(Ullrich *et al.*, 1984and Bang-Olsen *et al.*, 1987).** However, high lysine barley has only been commercialized for feed to a limited extent in Denmark, due partly to negative effects on kernel size, starch and grain yield (**Ullrich and Eslick, 1978b,c)** and partly to negative market forces relating to identity preservation (**Munck,1992).** One unreleased variety, Piggy (**Munck, 1992**) and two released varieties, Lysimax and Lysiba have been grown on limited acreages in Denmark (**Gabert *et al.*, 1996 and Jacobsen *et al.*, 2005).** There have been no attempts, to the authors' knowledge, to improve the functional properties of barley protein, nor has protein quality required for food uses of barley been defined, probably due to the relative insignificance of barley as a human food in modern times and lack of functionality of barley protein for making leavened bread and other baked products. A

possible linkage between protein and grain hardness of barley grain was recently reported by **Fox *et al.* (2007)** with the observation that environmental conditions that increased protein content also gave harder grain.

In general, protein content and protein quality of barley grain are not sufficient for highperforming monogastric farm animals. Consequently their diets have to be supplemented with other protein sources. The low content of essential amino acids (*e.g*. lysine and methionine) in barley proteins is a direct consequence of the high content of hordeins that are relatively low in these amino acids. Hordeins have been reported to interfere with the brewing process; the amount of extract that ultimately can be derived from malt is inversely related to the protein (hordein) content of the original grain.

Although barley has relatively high protein content, it does not have the same baking characteristics as wheat gluten. Therefore, typical barley bread has low bread volumes. Barley flour is primarily used in combination with other flours to make multigrain breads.

2.1.4.Total carbohydrates

Carbohydrates constitute the bulk of the total dry matter of the barley grain. Most of the carbohydrate in barley is starch which serves as energy source during germination. Over 96% of the total grain cellulose is present in the hulls (husks) **(Duffus and Cochrane, 1993).** Mono- and di-saccharides (sucrose, glucose, fructose and maltose) are present in lesser amounts, but their concentration is twice as high as in other cereals. Of the non-starch polysaccharide fraction the content of arabinoxylan (total 6.7% of which 0.4% is water soluble and β-glucan 4.6% (**Stölken *et al.*, 1996)** is of relevance when barley is fed to young monogastrics, due to the negative effects on digestion. It is noteworthy that contrary to this, the low-digestible carbohydrates especially β-

glucan and resistant starch have a positive impact on human health due to their role in lowering post-prandial blood glucose levels and in reducing the blood cholesterol level.

2.1.5.Minerals content

The major constituents of the mineral fraction of barley are magnesium, phosphorus, potassium, calcium, and sodium. The average mineral content varies significantly, and this appears to be due to a number of factors, including the variety in question, the growing and soil conditions and fertilizer application. A high portion of phosphorus in barley grain is bound to the phytate complex (51-66%) making much of the phosphorous unavailable to monogastric animals. Yet barley contains more phosphorous than common cereal grains and the phosphorous bioavailability of barley is higher than that in other grains . The amounts of copper, iron, manganese and zinc present in barley grain may vary to a large extent due to growing conditions and this has to be taken into account when diets for farm animals are formulated. As with vitamins these minerals are mainly concentrated in the embryo and the aleurone layer **(Duffus and Cochrane, 1993).**

2.1.6.Total lipids

Because the oil content of most hulled and hulless barley cultivars is low (<2%), obtaining oil from whole barley grain is not easy or economical **(Moreau *et al.*, 2007).** However, when barley is milled by various methods, some of its milling fractions are enriched in oil (up to about 10%), and these fractions are used to produce "barley oil" **(Lampi *et al.*, 2004)**. **Dunford, (2005)** grouped barley oil with other "germ oils" (including corn, wheat, and oats). In the mature barley grain the lipid content is approximately 3%. Lipids constitute only a small part of the dry matter in most barley tissues yet they comprise significant reserves in the embryo and the aleurone layer of the grain.

They are essential for the functional integrity of the cells.The majority of the lipids in barley are acyl lipids containing the fatty acids commonly found in higher plants, that is, myristic acid (14:0), palmitic acid (16:0), stearic acid (18:0), oleic acid (18:1, n-9), linoleic acid (18:2, n-6) and linolenic acid (18:3, n-3).

Barley contains approximately 0.8 mg/g sterols. Barley sterols include stigmasterol, β- sitosterol, campesterol, and cholesterol **(Piironen et al., 2000).** These may occur in the free form, as glycosides, esterified with fatty acids, or as acylated glycosides. Of the sterols, β-sitosterol is the primary sterol comprising about 60% of the total sterols in barley. Campesterol is the next most abundant sterol found in barley **(Piironen *et al.*, 2000).**

2.1.7.Other compounds

Barley also contains a number of other constituents, some of which, at higher intakes, have been suggested to have a role in protection against diseases **(Thompson, 1994**). These include simple phenolic acids, lignans, and the flavonoids. Ferulic, vanillic, *o*- and p-coumaric, syringic, *p*-hydroxybenzoic, sinapic and chlorogenic acids occur free in barley. Water soluble esters of *p*-hydroxybenzoic, protocatechuic, ferulic, vanillic, p-coumaric, syringic, caffeic, sinapic and isoferulic acids have been detected as have glycosides of several of these and of gentisic, chlorogenic and dihydroxybenzoic acids **(Briggs,1978).** Phenolic acids, principally ferulic but also p-coumaric acid, are covalently associated with arabinoxylans and constitute approximately 0.05% of cell walls in the starchy endosperm and 1.2% of aleurone walls. The insoluble, bound p-coumaric acid of barley grain is concentrated on the outer grain layers **(McGregor and Fincher, 1993).** Bacterial enzymes in the human colon slowly and partially degrade the aleurone cell walls. This degradation results in the release

of feruloylated oligosaccharides, which can then be further degraded to release ferulic acid. The phenolic acids are good antioxidants **(Rice-Evans *et al.* 1997).**

The flavonoids are a large group of phenolic compounds that occur widely in plants, and many of them have good antioxidant properties. Barley contains a range of flavonoids. Catechin, epicatechin, anthocyanins and proanthocyanins also occur in barley grains **(Briggs, 1978).** Barley also contains phytoestrogenic compounds, that is, isoflavones and lignans. Minor amounts of isoflavones are present in barley **(Murphy and Hendrich, 2002).** Lignans are phenolic dimers, which are predominantly present in the bran. Lignans are converted by fermentation in the large intestine to mammalian lignans **(Thompson, 1994).** The plant lignan secoisolariciresinol occuring in barley is converted by intestinal microbes into enterodiol and enterolactone **(Murphyand Hendrich, 2002).**

2.Net Blotch of Barley

Net blotch, caused by the fungal pathogen *Pyrenophora* Drechs. *teres* Smedeg. (anamorph: *Drechslera teres* [Sacc.] Shoem. f. *teres* Smedeg.), is among the most widely occurring foliar diseases of barley. The host range of the pathogen includes all cultivated and wild species of *Hordeum*. Estimates of yield loss due to net blotch range from trace to nearly 100% and vary from 10% to 40% in average years (**Mathre, 1997**). Yield losses are typically more severe in regions with high humidity and precipitation **(Ma *et al.*, 2004**). Net blotch may reduce grain quality affecting kernel size and malt extract yield (in malting barley cultivars). The yield component most severely affected by net blotch is kernel weight, which is commonly reported in terms of 1,000-kernel weight (**Mathre, 1997**).